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Ethical Epochs

GEORGE S. MORISON, President of the Civil Engineers more than a quarter of a century ago, wrote a book that he called "The New Epoch."

To the epochs enumerated by previous writers, marked by the use of fire, the bow and arrow, pottery, the domestication of animals, the manufacture of iron and the invention of the alphabet, he added the New Epoch marked by the use of manufactured power.

Passing through a tenement district not long ago, I saw a woman throw a milk bottle from an upper window. She watched it crash upon the pavement and turned carelessly away.

None of that sense that revolts at clutter and untidiness, no thought of possible suffering from injury of children playing barefooted in the street, and certainly not enough mentality to appreciate the economical effect upon her own condition if such practices were general.

A man stoops and picks up a nail from the gutter. Bantered about it, he half jocularly explains that in the first place it is a good nail and may come in handy. In the second place it is not a good thing to have in the street. Horses have been injured by picking nails up in their feet. They are not good for rubber tires. He had no horse and was not likely to be driving his car that way, but the more horses there were injured the more express and delivery service costs. The more tires there were injured the more they cost and he was buying tires and paying for getting them fixed.

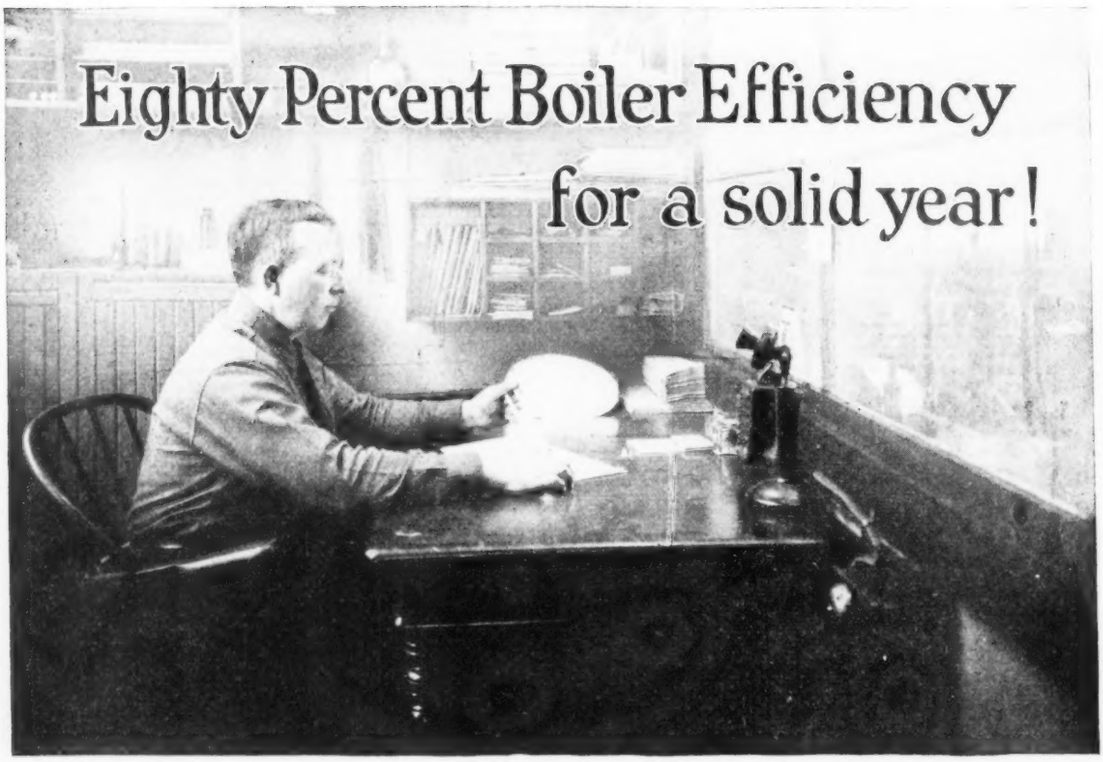
A second epoch. Indirect self-interest had become apparent.

An old gentleman stops and pushes with his cane into a catch basin a banana skin that a careless passerby has dropped on the sidewalk.

There was a story in the old readers, I think by Charles Lamb, of a man who stopped to cut down a thistle. Asked why he bothered, since it was nowhere near his land, he said that if everybody did it there would soon be no thistles.

Third epoch— Self-exertion with no immediate thought of self but of the Universal Well Being.

Eighty Percent Boiler Efficiency for a solid year!



Modern Equipment Plus Constant Tuning Up Explains Remarkable Results Obtained in Power Plant of Beggs & Cobb Tannery

WHEN a member of the *Power* staff visited, last month, the power plant of Beggs & Cobb Tannery at Winchester, Mass., and was told that the over-all boiler efficiency for 1926 averaged 80 per cent, he was inclined to claim Missouri as his birthplace. Who would blame him, seeing that neither air heaters nor economizers are used? The plant did remind one of Tiffany's and the staff was obviously on the job, but 80 per cent looked too good. However, the records were forthcoming, the over-all coal-water figures cross-checking with the records of flue temperature and CO_2, and the appearance of the ash. Incidentally, they have radiators in the boiler room to keep the firemen from freezing. Here are the figures and some interesting sidelights.

WHEN one of the *Power* editors recently called at the Beggs & Cobb Tannery, Winchester, Mass., to look over the power plant, it seemed that something of interest might develop. The facts, however, exceeded the expectations. John Casler, chief engineer, had plenty of records to substantiate his claim of an over-all boiler efficiency of 80 per cent for the year 1926.

All feed water had been measured by an integrating Venturi meter, and the coal had been weighed on the larry. Both scales and meter had been carefully checked. Moreover, records of flue temperature showed an average of 440 deg. in spite of the fact that no economizers or air heaters are installed. Repeated tests have shown a CO_2 almost constant at 14 per cent, and frequent inspections of the ash indicate that it is remarkably free from combustible. Low radiation loss is shown by the fact that radiators are required in the boiler room to keep the firemen warm.

The computed hot-gas flue loss for 14 per cent CO_2 and 440 deg. flue temperature is around 10 per cent, leaving a margin of 10 per cent to cover CO loss, carbon in ash and radiation. In view of the evident cleanness of the ash and the lack of waste heat in the boiler room, this margin seems ample, so that there is no reason to distrust the over-all efficiency computed from coal and water measurements.

During 1926 the coal burned amounted to 12,055,800 lb.; 140,071,000 lb. of water was evaporated from feed water at 220 deg. F. to saturated steam at 200 lb. gage pressure. This gives an actual evaporation of 11.61 lb. of water per pound of coal burned. This extremely high evaporation represents the combined effect of high efficiency, high feed temperature, the absence of superheat and the unusually high heat value of the New River Coal (reported as 14,700 B.t.u. per lb. as fired). From these data the over-all boiler efficiency can easily be computed as 80 per cent. In fairness to other plants it must be pointed out that the high quality of coal used is obviously of some assistance in obtaining this high efficiency.

The reported heat value of the coal may possibly be questioned in view of the fact that it is based on the coal company's report rather than on samples taken at the user's plant. However, the heat value could not be much higher, while a lower heat value would raise the efficiency figure above 80 per cent.

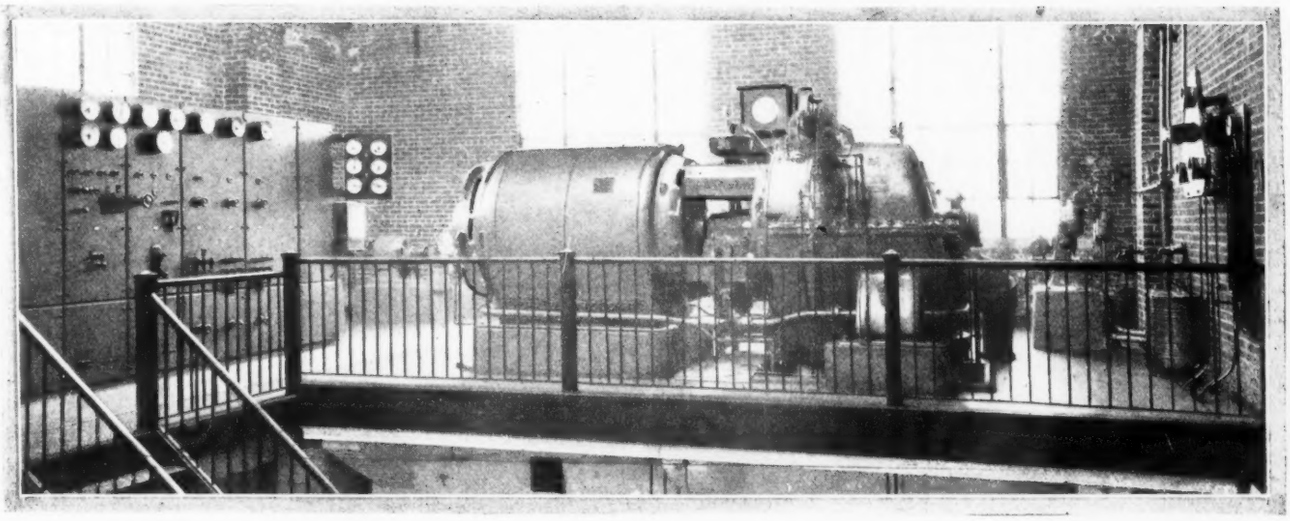


Fig. 1 (above) — Turbine floor showing switchboard, main turbine and oil purifier

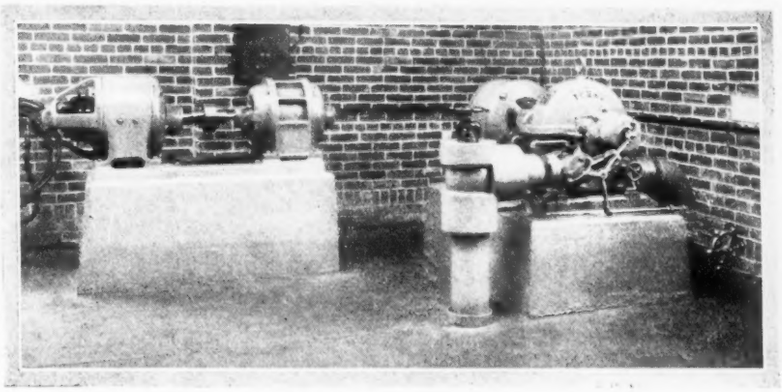
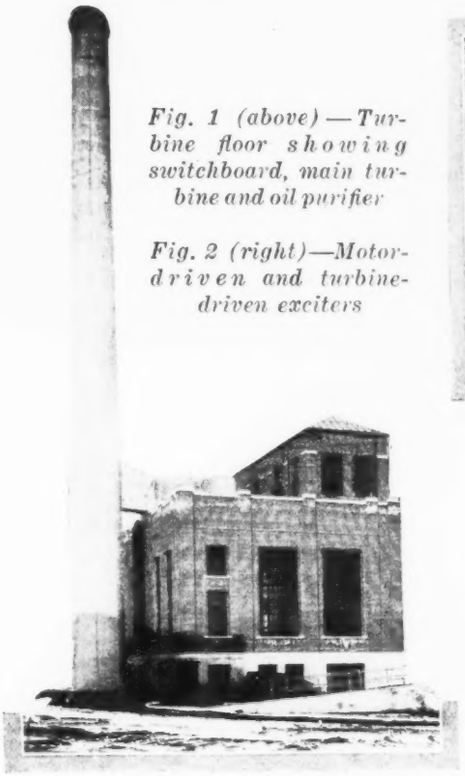


Fig. 2 (right)—Motor-driven and turbine-driven exciters



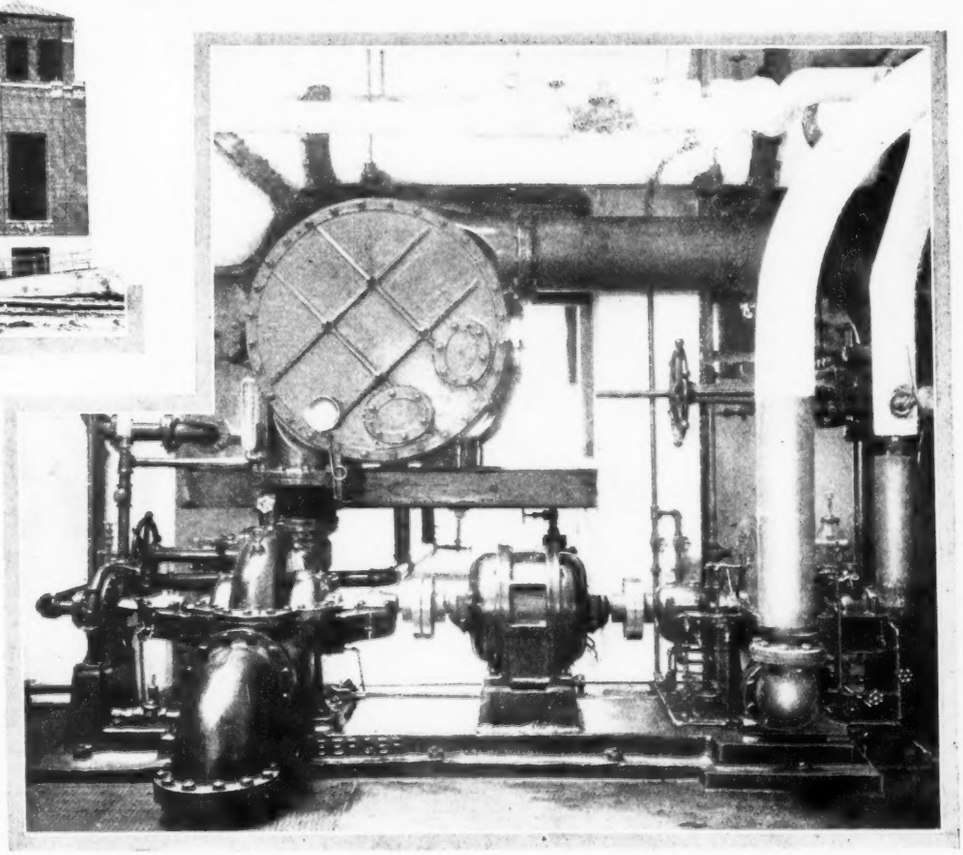
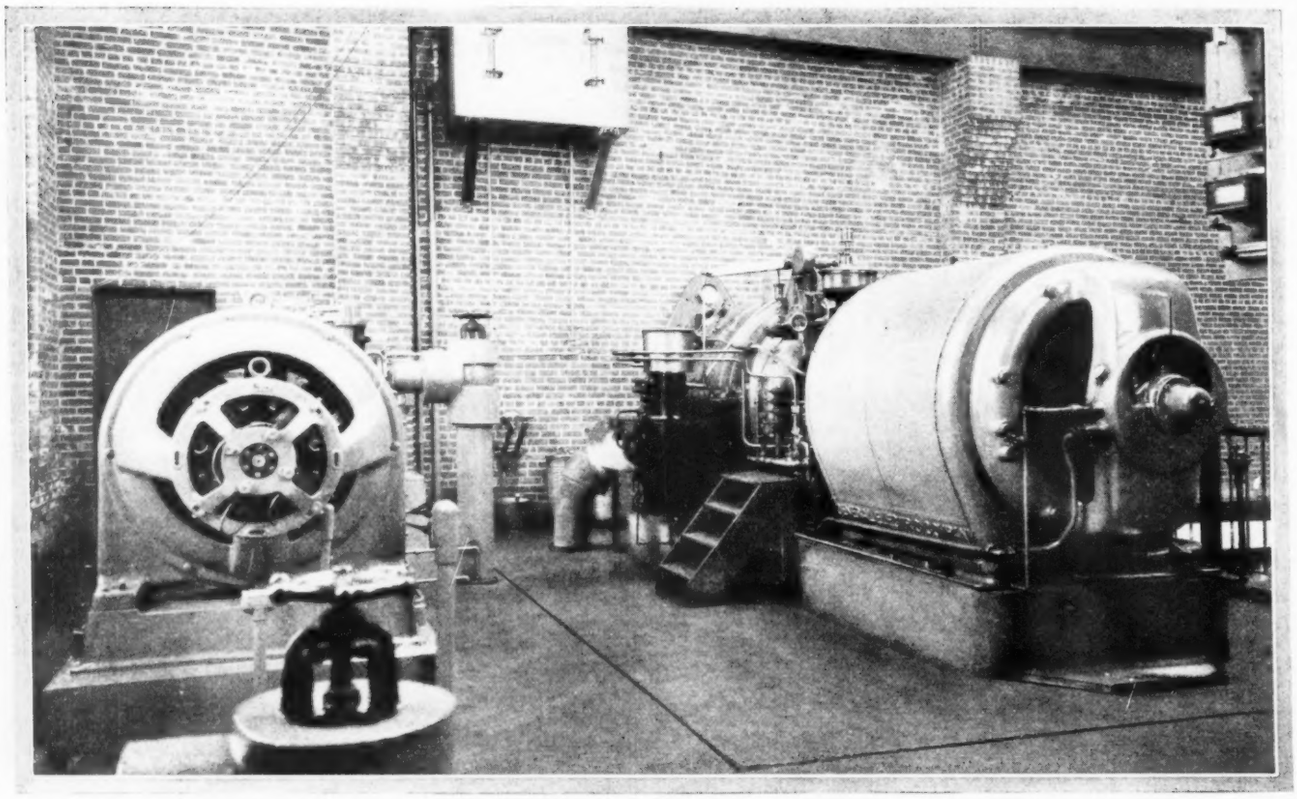


Fig. 3 (above) — General view of new power plant

Fig. 4 (right)—Circulating and condensate pumps on a single shaft with motor and turbine



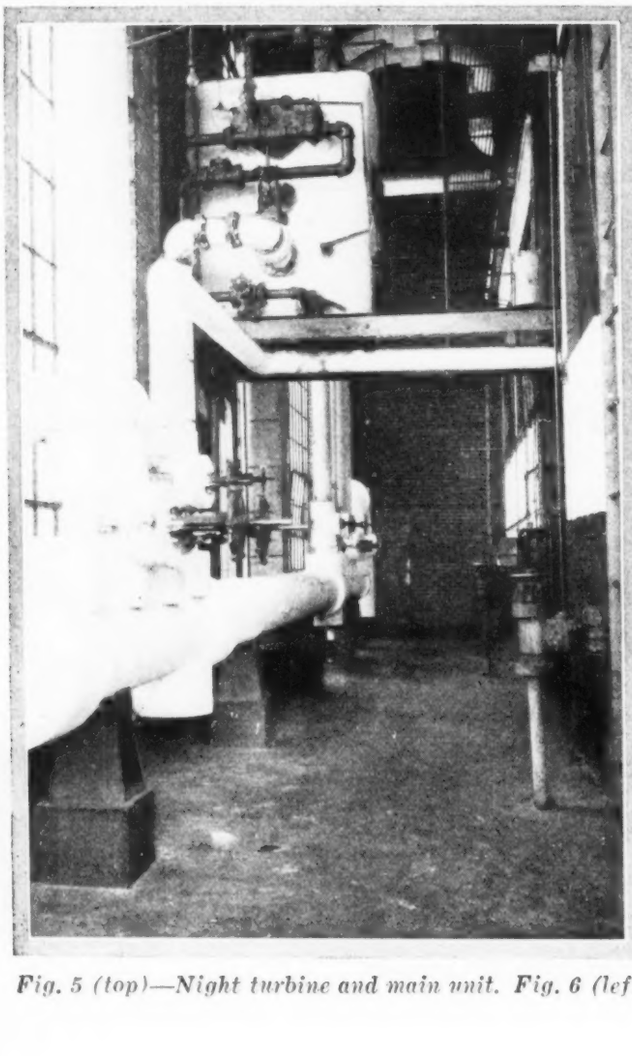


Fig. 5 (top)—Night turbine and main unit. Fig. 6 (left)—Behind the boilers. Fig. 7 (right)—Stoker-fired boilers

Because of the results obtained, the reader will naturally assume that the equipment is of high quality and maintained in the pink of condition. This is the case. The plant is a beautiful piece of engineering and is kept groomed to the limit at all times.

The whole place, from turbine to boiler-room basement, is as spick-and-span as a New England parlor. Mr. Casler will not tolerate dirt, or leaks, or puddles of oil, but he does not stop at the outside of the apparatus. When the boilers are opened, he goes inside himself to make sure that they are clean. His combustion-control apparatus is tuned up and adjusted like the pet outfit of a radio fan. The voltage regulator is taken completely apart and cleaned once a month. The attention given to details is shown by the fact that even the discharge from the stoker steam cylinders is piped to the heating system instead of being left to steam up the boiler-room basement.

Once a week the 550-volt oil switches are dusted off with compressed air. All exposed shafts, even including the stoker main-drive shaft along the boiler-room floor, are kept clean and polished at all times. Paint is used freely and frequently. If all this seems too much, the results obtained, which exceed those to be expected even with the best equipment, are their own argument.

A brief history of the plant will be of interest. The Beggs & Cobb tannery was started seventy years ago. It normally employs four hundred men and has a daily capacity of 4,200 sides (2,100 complete hides). Up to 1925 the original power plant was still in operation, although the horizontal return-tubular boilers had been replaced at intervals of twenty to twenty-five years. In 1925 there were eight of these boilers, burning 26½ tons of coal a day.

In the old engine room was an antique simple Corliss engine belted to a generator and a 150-hp. vertical engine somewhat less ancient, but decidedly out of date. Live steam was used for process, exhaust being used only for building heating.

Although the makeup water, which came from wells, was supposedly softened before its delivery to the boilers, scale one-half inch thick was found when the old boilers were dismantled after the completion of the new plant on an adjacent site.

In 1924 ground was broken for a new plant, designed by Edward C. Brown Company, Consulting Engineers, Boston. The plant went into operation on Jan. 5, 1925, at which time Mr. Casler took charge.

As may be seen from the accompanying photographs, the building is designed to present a good appearance inside and out, and to provide ample, well-lighted working space around all the equipment. Three stoker-fired water-tube boilers supply steam to a condensing turbine, bled for process and heating. Space is left for a fourth boiler. A small turbine exhausts to the low-pressure mains at night and during Sundays and holidays. Alternating current, three-phase, 60 cycle, is generated and distributed at 550 volts, all manufacturing equipment being motor-driven.

The building is of brick with a concrete stack 180 ft. high. Coal is handled from a dump pocket at the railroad siding to overhead bunkers by means of a bucket conveyor. A weigh larry delivers it to the hoppers of 5-retort underfeed stokers serving two 3,808-sq.ft. boilers and one 4,070-sq.ft. boiler. As already pointed out, New River coal is burned. The boilers are set 7 ft. 6 in. above the high end of the stoker tuyeres.

Draft is supplied by a single turbine-driven forced-draft fan. To prevent undue loss of draft by cooling of the chimney gases, the outside breeching is heat-insulated.

Ashes are discharged to handcars on trucks in the basement, which is notably clean and free from water and steam.

Stoker speed and air supply are automatically controlled, as is also the draft over the fire. Change of steam pressure operates simultaneously a regulator on the forced-draft-fan turbine and individual diaphragm speed-regulating devices mounted on the stokers. Stoker power is supplied by a single engine through a shaft running along the boiler fronts. A motor is also provided as a spare.

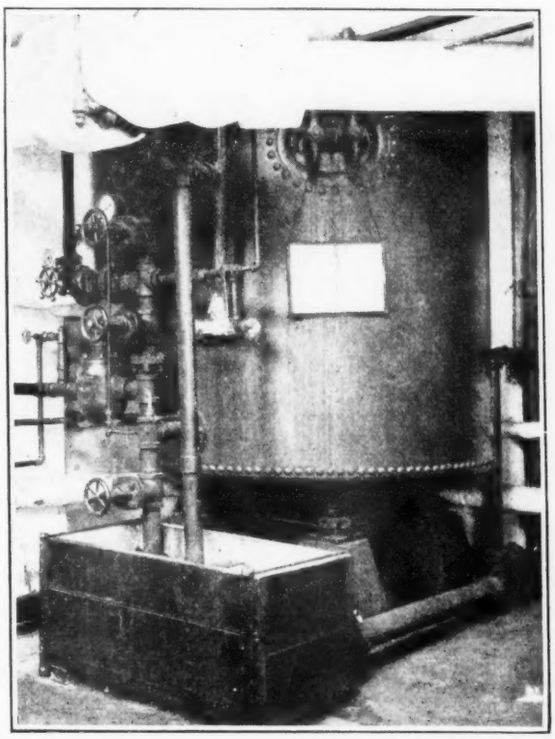


Fig. 8—Zeolite water softener eliminates scale troubles

A slight constant suction above the fire is maintained by control units with oil-actuated cylinders working the dampers through weighted chains passing over large pulleys mounted on the damper shafts. These regulators originally used water in the cylinders and actuated levers on the dampers, but it was found necessary to make the changes indicated to insure smooth and sensitive action. As now operated, the regulators are sensitive to extremely small variations in the over-fire draft. An exceptionally wide and well-lighted space is provided behind the boilers, giving ample room for overhead installation of the feed-water heater.

Since the water is heated to 220 deg. by steam at 5 lb. pressure, a considerable suction head is needed for satisfactory operation of the two feed pumps, which are of the steam-driven crank-and-plunger type. This is provided by locating the heater high above the boiler-room floor. These pumps are automatically controlled by feed-water regulators. Two simplex vacuum pumps (one of which is a spare) maintain an 18-in. vacuum on the heating system.

Figs. 1 and 4 hardly do justice to the turbine room, which might well serve as a model layout. Even on dull days the room and condenser basement are flooded with light.

On the main floor is the 750-kw. turbine generator already mentioned, with space for a second unit of equal or larger size. This operates at 3,600 r.p.m. and generates 575-volt three-phase 60-cycle alternating current. Saturated steam, entering at 200 lb., passes through a Curtis stage with two rows of moving blades, reducing the pressure to slightly more than 5 lb. for the bleeder connection.

After the heating and process requirements (averaging about 125,000 lb. a day) have been bled at this point, the remaining steam passes through four Rateau stages to a 2,000-sq.ft. surface condenser which maintains an absolute back pressure ranging from 1.75 in. of mercury in winter to 1.85 in summer.

At night and on Sundays and holidays the large turbine is shut down and necessary service maintained by a 120-kw. turbine generator exhausting directly to the low-pressure system. The exciter of this unit is mounted directly on the generator shaft.

The circulating pump and condensate pump of the main unit are mounted on a single shaft, together with a driving motor and a turbine which automatically picks up the load if the motor fails. Air is removed by a steam-jet "occluder."

Condenser circulating water is cooled by a spray pond holding about 175,000 gal. There are thirty-two 2-in. nozzles staggered on two levels. The water temperature never rises above that of the atmosphere.

There are two exciters for the main unit, one motor-driven and one turbine-driven. Makeup water, which comes from wells and has a hardness of about 155 parts per million, is softened by a zeolite softener which is normally regenerated with salt about once a day.

Recording instruments installed include three steam-flow air-flow meters with pens for flue temperature, a Venturi meter measuring the combined feed water, and a steam-flow meter for low-pressure steam, provided with two orifices so that it may measure the 5-lb. steam from either turbine (the two are rarely operated simultaneously).

A centrifugal purifier is installed to remove sludge and dirt from the turbine oil. The turbine room is served by a 20-ton traveling crane.

Among the operating details of interest are the following: Gage-glass blowdown and condensation from the turbine sealing steam is discharged to the hotwell. Soot is blown from the boiler tubes three times daily. When the boilers are opened, the engineer makes a personal inspection of their condition. Practically no scale is formed, but a very thin shell is removed by turbining once a year. Some precautions taken to insure cleanliness in other equipment have already been mentioned.

The history of the water bill in this plant is just one more instance of the cumulative effect of "small" economies. During the first six months the water bill was $580, running at the rate of $1,160 per year. The last bill that came was $69 for six months (a rate of $138 per year). Here is a tidy saving.

The proof of the pudding is in the eating. In 1924, with the old plant operating, the daily coal consumption was 26½ long tons on a 365-day basis. During 1926, with practically the same tannery output, it was only 14½ tons. As yet no attempt has been made to meter steam and electricity by departments. If arrangements are made to accomplish this, it seems reasonable to expect a still further substantial reduction in the amount of coal burned.

It is reported that the new plant is effecting a saving of about $50,000 per year in operating costs (fuel, labor, repairs, etc.) as compared with the old plants which it replaced.

Emphasis has been laid on operation because good operation is even more rare than good design. The reader will understand, on the other hand, that no amount of operating skill could have produced the results obtained except in a plant of most modern design.

Negligent Ash-Pit Operation

By A. L. H. Street

Because an employee in a steam power plant dumped live coals, etc., into an ashpit without ascertaining whether laborers were engaged beneath in removing former accumulations of ashes, thereby inflicting serious injury upon a fellow employee, the Appellate Court of Indiana lately upheld a judgment against the employer for $17,500, plus incidental court costs, etc. (McCullough vs. Union Traction Co., 154 North Eastern Reporter, 41). The main ground on which the employer was held to be liable appears in this language of the court:

"Exercise of ordinary care required that appellant should have installed some device or means which would warn employees working in or about the ashpits that appellant was about to dump the fire, ashes and refuse into said ashpits. Efficient signal systems were then in general use in like establishments and would not in any way have interfered with the efficient operation of said plant."

The court reaffirms the rule of law that it is the "duty of the employer to use every device practicable and possible to use for the protection of life, limb and health, limited only by the necessity for preserving the reasonable efficiency of the plant."

The $17,500 was not an excessive award for the injury sustained by plaintiff, the court holds, considering the excruciating pain he suffered, and in view of the facts that his hands were so badly burned as to be practically useless, that his face and neck were badly scarred, and that his earning capacity was permanently impaired.

The defendant company had posted statutory notice of its rejection of the Indiana Workmen's Compensation Act, as provided for by the terms of that law. By doing so, the company lost all right in this suit to rely upon a claim that the injured employee assumed the risk of such accidents or that his injury was contributed to by his own carelessness.

When an Air Chamber Is Attached to the suction side of a pump to steady the flow, it is frequently called a "vacuum chamber," but more properly is designated a suction air chamber. Properly speaking, there is no such thing as a vacuum chamber on a pump. The use of a suction air chamber is the reverse of that of the air chamber placed in the discharge side of the pump. The flow of water into a pump is due to atmospheric pressure alone or combined with pressure due to the suction head, and once the flow is started, for best results it must be continuous.

Series Contactors Applied to Starting Direct-Current Motors

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SERIES-TYPE contactors and modifications of this type have a wide field of application in the starting of direct-current motors. In this article the operation of one type of series contactor and its applications are discussed.

IN THE control of motors there are three general types of starters: (1) The current-limit type, where a relay or other control device keeps the accelerating contactors open on the starting peak of the motor; as the current decreases to a certain predetermined value, the contactor is allowed to close and short-circuits a section of the starting resistor. (2) The counter-electromotive-force type, which closes the accelerating contactors when the counter-electromotive-force of the motor has reached a predetermined value. (3) The time-accelerating type, where the closing of the accelerating contactors is governed by the closing of

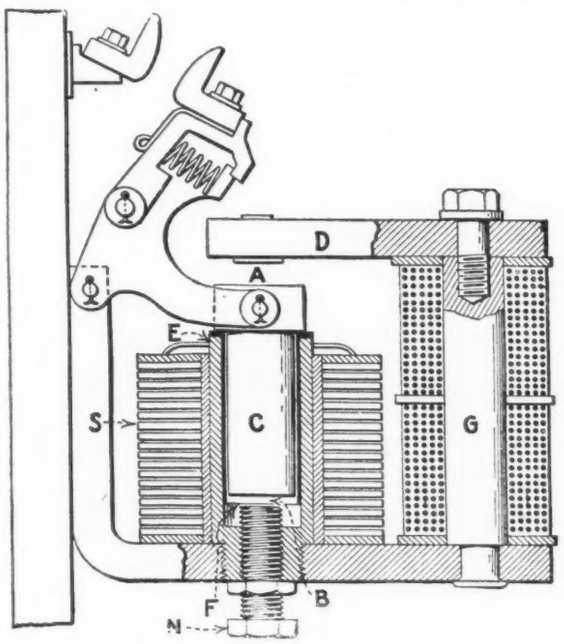


Fig. 1—Diagram of a series contactor with a shunt coil

one or more relays set for a predetermined time or by a dashpot connected directly to the accelerating device.

Of the foregoing, the series contactor falls in the first class. This type of contactor has its coil connected directly in series with the motor's armature. It is strictly a current-limit type and is applicable to a wide range of starting duties where current limit is required.

In its simplest form the series contactor consists of an armature which is allowed to move vertically, being guided in its movement by a hollow cylinder around which is placed a series coil. The coil is so wound that when a current is passed through it, the flux produced tends to lift the armature and close the contact fingers.

To allow the contactor to close at various values of motor current, there is an adjustable gap B between the armature and an adjusting screw N in the magnet frame, as shown in Fig. 1. This gap is called the lockout

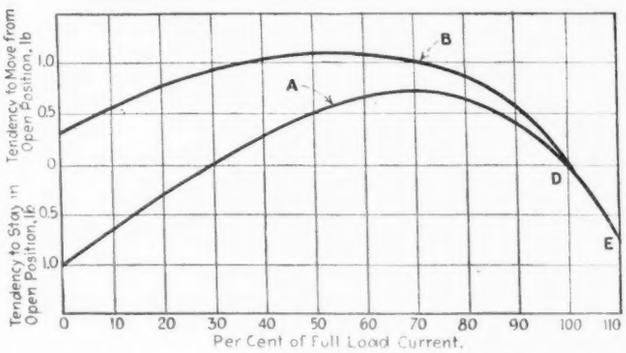


Fig. 2—Curves showing the closing and lockout forces acting on the series contactor, Fig. 1

gap. The upper gap A or space between the armature and frame, is called the pull-in gap and tends to close the contact tips when a current is passed through the series coil S. This gap is not adjustable. The value of current at which the contactor closes when the series coil is energized is called the calibration value.

When the armature circuit of the motor is closed, the inrush current of the motor through the series coil sets up a flux through the magnetic circuit CDG. The magnetic sleeve E is so proportioned that the density of the magnetic lines in it is much higher than the density in adjusting nut N. The flux through N across gap B into core C causes a downward pull on the core. Practically all the flux passing through core C will flow across gap A to the magnet frame D and will tend to lift the core and close the contactor. When the current exceeds the calibration value determined by the length of gap B compared to A, the downward pull on core C plus the weight of the core is greater than the pull from C to D, and the contactor is locked open. As the motor accelerates and the current decreases in the series coil, the flux in the circuit CDG decreases. Owing to the design of sleeve E the flux in this section decreases more slowly than the flux in gap B when the current is reduced. Therefore, a point is reached where the pull across gap B is less than the pull across A, and the contactor closes. The brass tube F prevents the lower part of armature C from sealing to core E and also serves as a damper to give lock-out.

The operation, as explained for Fig. 1, is represented

by curve *A*, Fig. 2. The values given for these curves are for a particular designed contactor and will vary for different sizes and designs. For this particular contactor, when the current exceeds 100 per cent full-load rating, the downward pull on the contactor core exceeds the upward pull, which is indicated by the part of the curve *D* to *E* below 0 pull line. Therefore, when the current through the series coil exceeds 100 per cent rating, the contactor will remain open. As the motor's speed increases and the current decreases below 100 per cent, the upward pull exceeds the down pull and the contactor will close.

From curve *A* it will be noted that the pull tending to hold the contactor in its normal open position with the current at zero value in the coil is one pound. This represents the gravity pull or the weight of the armature. The curve *A* crosses the zero pounds line at 30 per cent current, at which point the contactor is on a balance when a small increase in current will start a movement of the armature upward, tending to close the contact fingers. Any decreases in current below 30 per cent full-load value will tend to cause the contactor to stay in the open position. The opposite is true at the 100 per cent current point, therefore the contactor will close on any value of current between 30 per cent and 100 per cent.

It should be understood that the curves shown in Fig. 2 are for a current-limit setting of 100 per cent. Other curves would result if the calibrating nut were moved, only the negative torque at zero current remaining fixed. When the current increases suddenly, the magnetic characteristics of the contactor are such that it locks open during the short period that the current

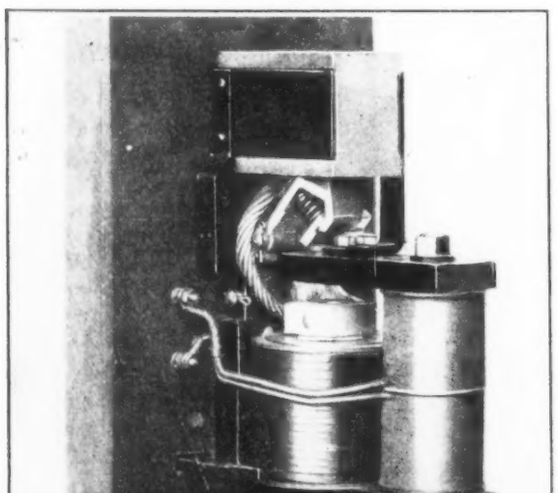


Fig. 3—Typical series contactor with shunt coil and equipped with a blowout coil and arc chute

is reaching a lockout value and the contactor remains open, so that the contactor closes only on a decreasing current in normal operation. If the current through the series coil were increased slowly, when 30 per cent value was exceeded the contactor would close, but when the current is increased suddenly, such as when the motor is first connected to the line, the magnetic action is such that the flux density builds up fast enough in gap *B* to lock the contactor open, and it will remain open as long as the current in the coil remains above the lockout value, which in this case is 100 per cent.

A modification of the straight series contactor is one with both a series and a shunt coil. The shunt coil is capable of closing the contactor without the aid of the series coil. The torque curve then of the shunt coil

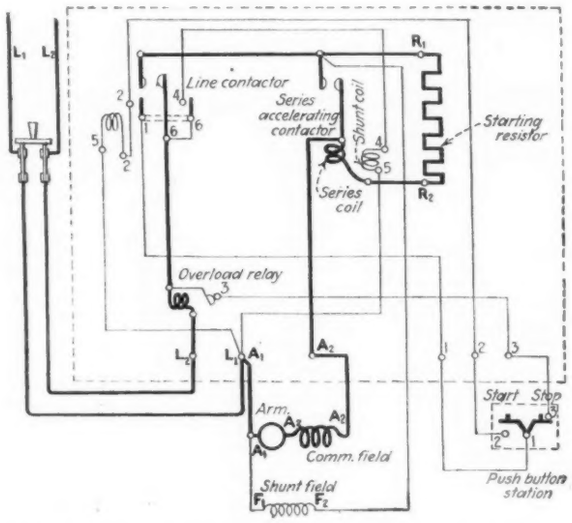


Fig. 4—Wiring diagram of automatic motor starter using series contactor

by itself could also be represented in Fig. 2 by curve *A*. If both the series and shunt coils were energized at the same time, the torque tending to close the contactor could be represented by curve *B*. There are some applications where the shunt coil is not energized until the series coil has closed the contactor. In such cases the shunt coil is used as a holding coil for the contactor. The normal voltage variation on the shunt coil does not affect the calibration of the contactor.

An important feature of the series contactor when using a shunt coil is that, with both coils energized after the contact tips have closed, the contactor acts as a reverse-current device and opens on a certain value of reverse current in the series coil. This combination is generally used on controllers for adjustable-speed motors, when there is a possibility of short-circuiting the field rheostat, or of returning the rheostat handle toward the off position at a rapid rate, thereby changing the field strength suddenly, resulting in a high armature current being pumped back into the line with consequent flashing at the commutator. This action is known as pump-back and is prevented by the series contactor, which will open on a reverse current of approximately 60 per cent value, inserting resistance in the motor's armature, thus reducing the armature current, and is what is known as pump-back protection.

Another modification of the series contactor, although theoretically its operation is the same as previously described, is one having in place of a series coil a shunted-series coil or, strictly speaking, a shunt coil connected across the total starting resistor. This application always uses a shunt coil in addition to the shunted-series coil.

The advantages of series-contactor type starters may be summed up as follows:

1. The lockout or current-limit value of torque is positive, making the contactor more stable and less

likely to close at improper values when subjected to vibration.

2. There is a large variation in calibration range, thus permitting an easy and accurate setting of the contactor.

3. In addition to the series coil a shunt coil may be used which is capable of closing the contactor without the aid of the series coil.

4. Pump-back protection is obtained when both series and shunt coils are left in circuit.

Fig. 3 shows a typical series contactor fitted with shunt coil and equipped with a blowout coil and arc-chute.

The simplest form of starting equipment for a motor using the series contactor is that shown in Fig. 4. In

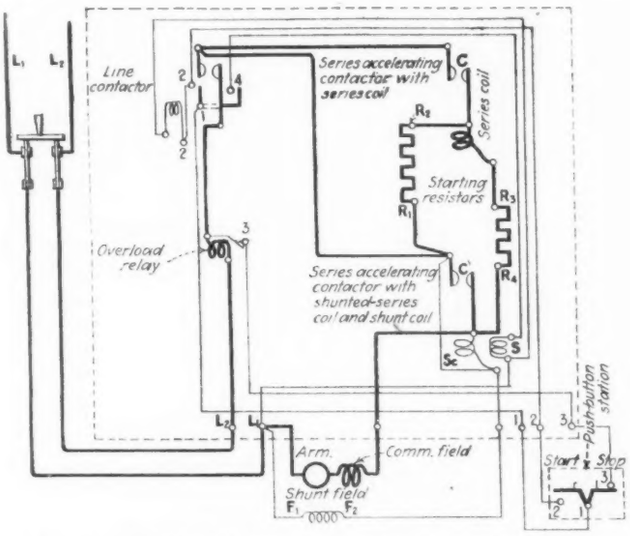


Fig. 5—Wiring diagram of automatic motor starter using shunted series coil and shunt coil

this case the accelerating contactor is a series type with a shunt holding coil. When the start push button is depressed, a circuit is made from L_2 through the overload relay to 3 on the push button, to 2 on the line contactor coil, through this coil to 5, which completes the circuit to line L_1 and closes the line contactor. A circuit is then made from L_2 line to 3 one the push button and through interlock 1, to 2, through the line-contactor coil and to L_1. This circuit holds the contactor closed when the push button is released. Closing of the line contactor completes the motor circuit from L_2 through the line-contactor, the starting resistor R_1 to R_2, the series coil, through the motor's armature A_2 to A_1 and to line L_1. The motor will then start, and the inrush current at starting is sufficient to lock out the accelerating contactor as explained previously. As the motor accelerates, its armature current will decrease until a value is reached where the contactor closes.

It will be noticed that, when the accelerating contactor has closed, the series coil and the starting resistor are short-circuited by the accelerating-contactor tips. In this case it is necessary to have some means of holding the accelerating contactor closed. This is accomplished by providing a circuit from L_2 through interlock 4 on the line contactor, the shunt coil of the accelerating contactor to L_1, which energizes this coil and the contactor is held closed.

Another typical application is shown in Fig. 5. If a motor starter consisting of straight series contactors were used for accelerating a flywheel load, and if after reaching full speed power was cut out of the motor and the start push button closed while the motor was still rotating, the series contactors might not close because there might not be sufficient current inrush through the motor. The motor would then be running with the resistor in circuit and would not reach full speed. To overcome this difficulty a shunted-series coil is used in place of the series coil on the last accelerating contactor, together with a shunt coil that is energized at the same time as the line contactor.

With the shunt coil energized at the same time as the line contactor, it is necessary to obtain lockout at the time the shunt coil is energized. This is impossible with a straight series coil, as it is energized after the preceding accelerating contactor closes. Therefore, the shunted-series coil S_c, Fig. 5, is connected across the total starting resistance, as from R_1 to R_4, and current flows in this coil giving lockout as soon as the line contactor closes.

Voltage Applied to Shunted-Series Coil

The normal voltage rating of the shunted-series coil is equal to full-load current times the last section of resistance. That is, if there is two ohms resistance from R_3 and R_4 and the full-load motor current is 32 amperes, then the shunted-series coil would be rated at $2 \times 32 = 64$ volts. Assuming that the ohms from R_1 to R_2 is four, or twice that of R_3 to R_4, then, if there is full-load current flowing, the total voltage drop across the resistance is $6 \times 32 = 192$ volts. In this case the shunted-series contactor will lock open. Assuming a condition where the motor is running light with only three amperes flowing, the voltage drop across the total resistor is then only 18 volts, which is not enough to close the contactor. Since the shunt coil will close the contactor without the aid of the series coil, the contactor will close and prevent the motor from running with the resistor in circuit.

On the controller, Fig. 5, the closing and holding-in circuits for the line contactor are the same as in Fig. 4. With the line contactor closed, the motor circuit is from line L_2, through the line contactor, resistor R_1, R_2, the series coil, resistor R_3, R_4, the armature and to line L_1. The shunted-series coil S_c is connected to the resistors from R_1 to R_4 and is subjected to the full voltage across this resistance, which causes a current to flow that locks this contactor open. As the motor accelerates, the current through the series coil decreases to a value where this contactor closes. When contactor C closes, resistor R_1, R_2 is short-circuited and the armature circuit is from the line contactor, through contactor C, the series coil, resistor R_3, R_4, the armature and to the line. As the motor increases in speed, the voltage across the shunted-series coil decreases and reaches a value where this contactor closes.

When contacts C' close, the motor is directly across the line, and the shunted-series coil, the series coil and resistors are shunted out of circuit, so that the series contactor C opens. Contactor C' is prevented from opening by the shunt coil S which is connected across the line from interlock 4 or the line contactor to line L_1. As previously explained, if the power to the motor is temporarily interrupted, and when the motor is made alive again, the inrush current is not high enough to cause the accelerating contactors to function normally, the shunt coil will close contactor C' and cut the resistance out of circuit.

Recent Developments in Coal Burning*

POSSIBILITIES of the unit mill and the difficulties of burning Illinois coal as compared to high-grade Eastern coals. Advantages of the unit mill contrasted with those of the bin and storage system

WITH the introductory comments upon the rapid development of the forced-draft chain grate to meet the increasing demand for high evaporative rates, flexibility and control of combustion, the difficulties encountered after the application of preheated air, and the advance that has been made in coal burning capacity and economy in the underfeed stoker, F. S. Collings,[1] the author of the paper, turned to the burning of coal in pulverized form, which together with the water-cooled furnace, he considered the most important advance of this decade in the art of steam generation.

Although the central preparation plant had many advantages and was producing excellent results, it was considered somewhat too expensive and complicated for use in small plants or even in large ones burning a cheap grade of coal. This situation has resulted in the development of the unit mill in which the raw coal is fed direct from storage to the mill and thence to the burners. The unit system did not necessarily exclude the coal drier, but it was beginning to be recognized that the drying of coal before pulverizing was neither as essential nor as desirable as was formerly believed.

Some Unit Mills Handle Wet Coal Successfully

There were certain types of unit mill that would handle wet coal with complete success, and while the process absorbed more power per ton ground than did the grinding of dry coal, the difference between 9 and 15 per cent moisture content did not increase the total station auxiliary power more than 1½ per cent. This small loss was more than offset by the losses due to the drying process, which included the fixed charges on the drying equipment, the loss of coal dust entrained with the gases from the drier, the loss of coal dust discharged from the mill vents, and the loss due to the volatiles released by low-temperature distillation at or above 300 deg. F. and carried off through the vents.

An alternative method of partial drying much in use was to preheat the primary air to the mill, and in this case no loss was involved, since all dust and all gases released in the mill by heating were discharged direct to the coal burners. The amount of this air varied with the unit mill operation from 30 to 70 per cent of the total air required for combustion, and when heated to between 300 and 350 deg. F. had the effect of increasing the capacity of the mill and reducing the power absorbed per ton of coal in proportion to the volume and temperature of the air supplied.

Introducing the air at the back of the setting, leading it through the side wall ducts and finally admitting it to the furnace at the front or sides, prolonged the flame propagation to a degree that necessitated a large furnace and probably a reversal of flame travel to prevent impingement on the walls or on the boiler tubes, as well as to provide the required time for complete mixture and combustion. The admission of all the air at or around the burner, on the other hand, produced a short flame, a localized "hot spot," permitting the use of a relatively small furnace.

Developing the Application

Much of the credit for developing unit-mill application to large central stations was given to E. H. Tenney and the work done in St. Louis briefly reviewed. Until recently it had seemed questionable if the gain in capacity and efficiency in burning pulverized Illinois coal, as compared to the use of high-grade Eastern coals, would offset the additional investment charges from the cost of the installation. In the Illinois coal there was almost three times the ash to contend with, and in addition it had other unfavorable characteristics, such as a low fusing temperature, averaging 1,940 deg. F. and high percentages of sulphur and of iron. The importance of the sulphur content was due mainly to its corrosive action on the heating surfaces, smoke ducts and fans. The high percentage of ash made the pulverizing process more difficult. High moisture and hydrogen contents constituted definite losses, but the real disadvantage of Kinkaid coal was that it required about 50 per cent more pulverizing equipment, more furnace volume and more fan and mill output for the same steam output, so that fixed charges were a matter for serious consideration.

Iron and sulphur in the ash combined with the elements of the furnace brick to the destruction of the latter, but the formation of slag was perhaps one of the worst characteristics of the high-ash Western coals. Owing to the low fusion point molten ash was carried through the first few rows of tubes and deposited in the form of slag above the drop leg. Slag also deposited on the firebrick lining of the masonry setting and, by erosion, by combination and by the physical damage due to the work of removing it, greatly shortened the life of the furnace.

With pulverized coal the ash problem in the upper tubes assumed large proportions, but as much of the

*Abstract of paper presented before the Midwest Power Conference, Chicago, Feb. 18, 1927, with report of discussion.

[1]Mechanical Engineer, Sargent & Lundy, Chicago.

finely divided ash was carried entirely through the boiler unit and up the stack, the actual fouling of the surfaces probably would be less than in the case of a stoker plant.

It was the author's opinion that the water-cooled furnace wall was the best present solution to the problem of maintaining high evaporative rates, together with the lower excess air necessary to efficiency, without excessive furnace maintenance. It did not seem practicable to cool a hollow wall by the circulation of air to a temperature below the fusion point of the ash, whereas it did seem probable, although the question was still open to debate, that the temperature adjacent to the water-cooled wall would be reduced sufficiently to cause the slag formed in the "hot spot" to solidify as it approached the tubes and drop to the bottom of the furnace.

Some Advantages of Pulverized Fuel

Some of the advantages of pulverized fuel, applying more particularly to the unit mill of the air-removal type, were as follows: Flexibility to meet load variations and produce high rates of evaporation over the peak, elimination of banked fires while burning with good efficiency the small amount of coal required to keep the boiler under steam, about 1 to 1½ per cent higher efficiency under test conditions than with the modern stoker, and considerably better month-to-month results, owing in part to better control on a swinging load and the possibility of maintaining excess air at a minimum.

The pulverized fuel furnace was well adapted for burning fuel oil or gas, and if the burners were suitably cooled when not in use, the operation could be changed from one type of fuel to another without interruption. In the burning of the low-grade solid fuels to be found in the oil and natural gas states, the unit mill was proving to be a cheap and economical factor. For example, the author had witnessed a test in McAlester, Okla., in which Texas lignite having a total moisture content of 37 per cent had been pulverized in a unit mill and burned with good results.

With pulverized coal it was practicable to use air at the maximum temperature available from the standard types of air preheaters, which was in the neighborhood of 600 deg. F. This permitted the use of a large air heater instead of a combination of economizer and air heater, without increase in stack temperature. It was difficult to proportion an economizer for service over a wide range without either excessive pressure drops through both gas and water sides at high evaporative rates, or a marked reduction in the heat transfer rate due to low velocities at low ratings. At low ratings and on bank the economizer suffered from external corrosion due to the combination of high sulphur and moisture content of the average Western coal. From this cause the air-heater suffered also, but to a less degree, and furthermore, its failure from this cause would not be disastrous or even particularly inconvenient at the time. Without the economizer it was possible to increase greatly the extraction of steam from the main units for feed-water heating, with a consequent increase in over-all plant efficiency.

The Author's Conclusion

In conclusion, the author made it evident that it was not his intention to express any belief that the pulverized-fuel system, or the water-cooled furnace, or a combination of the two constituted a universal remedy for poor furnace conditions, low capacity and boiler-room evils generally. Nor might they be expected to take the place of all existing coal-burning installations as a means of improvement. It was probable that the best modern stokers burning a high-grade Eastern coal, low in moisture, ash and sulphur, and with ash fusing at from 2,600 to 2,700 deg. F., might produce results in a masonry setting equal to those obtained from a pulverized-fuel plant under similar conditions.

But considering Midwestern coals, with low heat values, high moisture, ash and sulphur contents, and possessing the most undesirable ash characteristics, it was his belief that it would be necessary to seek other methods of burning the coal economically than upon the complicated and expensive stoker. The slagging qualities of the ash would make it desirable to turn to the water-cooled furnace as a step toward low maintenance and continuity of service. Add to this the great additional steaming capacity, with its consequent reduction in building costs, of this highly efficient surface inclosing the radiant heat zone, and what was originally only a means of relief from some of the difficulties, became also a valuable asset.

In the final analysis it happened fortunately that the needs of the boiler room harmonized with the interests of the plant as a whole, for while the water-cooled furnace made practicable the high evaporative rates obtainable with pulverized fuel, the adaptability of the pulverized fuel system to high air temperatures permitted the large air preheater, the reduction or elimination of the economizer, and the recovery of latent heat by the regenerative cycle to the limit of the capacity of the feed water to absorb it.

John Anderson Favors Storage System

Drawing from his experience during the last eight years with the bin and feeder system, and with the unit system for a period of four years, John Anderson, of Milwaukee, did not believe that the storage system of firing was too expensive and complicated to justify its use in a small plant, or in large ones burning a cheap grade of coal. A recent comparison of a storage versus a unit system for a 100,000-kw. installation made it clear that there was no reason why the investment in the storage system should be any greater than in the unit-fired type if the same conservatism was practiced with respect to spare capacity with both types. The mistake was made frequently of considering a plant that involved only a unit pulverizer in front of the boiler. This type of plant was not suited to the man who wanted the highest grade of design as to efficiency, capacity and freedom from interference with operation.

With the author's statement that the drying of coal before pulverizing was neither as essential nor desirable as formerly believed, Mr. Anderson did not agree. A unit mill designed for firing coal of a certain moisture, was at a distinct disadvantage as to efficiency when the moisture was increased temporarily, and at the same disadvantage if the coal should be drier than that for which the mill had been designed. All three conditions of, extra, normal and minimum moisture gave an output in the mill that varied correspondingly and affected not only the capacity, but the fineness of the product.

As the hammers wear, unit mills vary as to fineness of product. The power required per ton varied with the rating at which the mill was operated. A unit mill designed for a maximum rating would not operate eco-

nomically as to power, nor satisfactorily as to fineness, at any other rating.

Issue was taken with a statement by the author regarding the use of smaller furnaces. Mr. Anderson was definite in his view that a large furnace was to be preferred, not only because it gave an opportunity to complete the combustion of the coal in the furnace, but principally that the furnace of larger size lends itself to the installation of radiant heat surface, which, in the light of late developments, must be regarded as the most valuable and most efficient heat-absorbing surface of the entire installation. Then again, a large furnace permitted the separation of the ash in the furnace. His experience with the 1,200-lb. boiler at the Lakeside station showed that better than 30 per cent of the ash was precipitated in the furnace bottom, and that this ash was entirely devoid of carbon, as must be the case when it is confined in the furnace for a period of hours.

Greater Efficiency Claimed for Storage System

With the statement of the author that satisfactory results had been obtained with unit pulverizers at the Ashley Street Station, both as to capacity and efficiency, Mr. Anderson agreed with the capacity part of the statement, but claimed that when the tests to which the author had referred, had been divested of the effect produced by the double economizer, the results would be not quite equal to those from an ordinary stoker installation. A lot of misinformation had been published about this plant that should be better understood to prevent engineers following a lead that would get them into trouble about the time their installations were complete. He had had experience with unit firing as far back as four years ago, and in his opinion no material improvement had been made in unit pulverizers since then. At present he had a unit installation at the Oneida Street plant, side by side with the original bin and feeder system installed in that plant in 1918. As to comparative results, he maintained that over months of operation a difference of 6 per cent efficiency would be found between the two types of firing.

How Friability Affects Cost of Pulverization

Rather than the quantity of ash, Mr. Anderson considered the friability of the coal the one characteristic that had any real bearing on the cost of pulverization. His experience had shown that some of the high-ash coals of Illinois would grind more easily than the coals of Pennsylvania and West Virginia. He regarded the brick furnace as a thing of the dark ages. Water or steam cooled furnaces must form a part of every modern plant, not only because this surface takes advantage of the radiant heat, as well as that of convection, but because there could be no such thing as destruction of furnace walls, if no brick were used in the design. Large furnaces, properly cooled, would prevent troubles from slag. The practice of air-cooling walls that had been prevalent three years ago had now been forgotten.

Giving both systems the advantages of the same considerations with regard to margins of capacity and fully evaluating the advantages that accrue from a coal scientifically prepared, which can be relied upon at the furnace inlet for a proper condition as to quantity, amount of moisture and fineness, Mr. Anderson contended that a decidedly favorable report could be made on the storage design of plant.

Mr. Drewry, who had read the discussion, enlarged upon the matter of taking advantage of the storage part of the system by shutting off the pulverizing mills during peak loads and the advantages of increased radiant heat absorption from higher CO_2 and lower excess air.

Lundgren Reviews Drying Methods and Power Requirements of Unit Mills

Edwin Lundgren, of the Combustion Engineering Corporation, gave as a reason for the increasing use of pulverized fuel, the greater evaporation rates that could be obtained from a boiler occupying a certain space, the ease of operation and the continuous high efficiency through the absolute control of the air and fuel. Another factor, favoring powdered coal, was minimum outage. Assuming that the prior difficulties, such as air-cooled walls and refractories, had been removed, there was no reason why powdered-coal boilers should not stay on the line for a period of a year, or even two years, as compared to a maximum period of continuous operation of 35 to 45 days in a stoker-fired plant.

Referring to the paper by Mr. Collings, Mr. Lundgren reviewed the troubles that had been experienced in the various types of driers, including the clumsy rotary drier, the waste-heat drier and the various modifications of steam drier, none of which was considered a real solution of the problem. At the present time there were some interesting developments going on in which the drying would be done in a newly designed mill that held out great encouragement.

As to the unit system being a solution of the difficulties in the pulverized-fuel field, it was only now that users were gathering operating figures and beginning to learn the difficulties to be encountered. The unit mill had all the drawbacks that any machinery for pulverizing fuel had. Moisture content decreased capacity and wear of the hammers decreased the fineness of the coal. Variable mixtures of coal and air lowered efficiency. In the power for grinding, it was the physical structure of the coal that counted rather than the percentage of ash, although the more ash the more grinding that would be necessary to produce the same number of B.t.u. That power requirements per ton varied with the capacity at which the mill operated, was verified by results from a certain mill which took 15 kw.-hr. per ton at full capacity and 56 kw.-hr. at one-third capacity.

In the storage system there had been drawbacks because of the requirements for driers, etc., but today these had been solved and the use of that system discarded all the troubles from different coals coming to the bins, of changes in moisture content and of decreasing capacity. Means were provided for continuously feeding the proper amount of coal to the furnace as the steam requirements demanded, and of supplying the proper amount of air. In the control of these two essential factors lay the reason for the success of pulverized fuel.

Rebuttal by Collings

To Mr. Collings it seemed inevitable that the additional equipment used in the storage system, with the additional building space required to accommodate it, must involve a greater investment per ton of coal fired. The coal driers and their connections, the pulverized-fuel transport and distributing system, the pulverized-fuel storage bins, feeders and controls necessary to the storage system, constituted a large part of the investment which may be eliminated in the unit system.

Within the last four years it had been found to be both practicable and satisfactory to pulverize and burn coal as received, without drying outside of the mill. It was true that a unit mill was affected distinctly in both efficiency and output by variations in the moisture, but the storage system mill was affected similarly and for the same reason, for it was not practicable to maintain a continuous series of moisture determinations at the drier outlet for the purpose of regulating the drier so as to give a constant product under varying conditions of moisture at the drier inlet.

Mr. Collings did appreciate the value of large radiant heat surfaces and in his paper did not intend to imply that a large furnace was undesirable, but rather that increasing flame propagation by the admission of secondary air through ports in the furnace wall made it necessary to use a larger furnace than need be used for the designed steaming capacity of the boiler.

The intent of the paper was to point out the disadvantages of the refractory setting, and the great superiority of the water-cooled furnace, for the consideration of those engineers who might be contemplating the re-design or extension of existing stations of the older type, for there were many plants in existence that still used refractory furnaces.

With reference to the statement that Kincaid coal required 50 per cent more pulverizing equipment per kilowatt-hour than did West Virginia coal, this was merely a question of simple arithmetic. To deliver a given number of available heat units to the burner, it was necessary to pass 50 per cent more gross tons of the high-ash, high-moisture, low-B.t.u. coal through the mill than was the case when using the high-grade coal. Rated mill capacity was an arbitrary figure and usually was stated in gross tons per hour. The effect of high ash on the pulverizing process was a subject entirely open to discussion.

Combustion in pulverized-fuel furnaces involved thorough mixing of coal and air, length and direction of flame travel. These factors had been worked out quite thoroughly with the bin system, and were being worked out with a marked degree of success with unit mills.

Tenney Backs the Unit Mill and the Results at Ashley and Cahokia Stations

E. H. Tenney, of St. Louis, believed that Mr. Collings had ably presented the facts indicating the latest trend in the application of pulverized-fuel burning, and that the field might well afford to give careful thought to more simple methods of design, construction and operation of large central stations, particularly as to the use of unit pulverizers for pulverized-fuel firing.

In his discussion Mr. Anderson had referred to an analysis made at Milwaukee of the costs of a hypothetical, not actual, 100,000-kw. installation in which he stated that the storage design was neither expensive nor complicated. The analysis referred to in no way indicated the comparative costs of the two systems, in that it was only by adding $154,000 for 1,194 kw. excess auxiliary power to an already "loaded" unit-system estimate, that the estimated costs of the unit system were at all comparable with a doubtful storage-system design and estimate. The addition of this large sum to the unit-mill costs to bring the peak load capacity of the unit system up to that of the storage system, was not justified by actual operating experience.

Relative to drying, Mr. Tenney stated that present designs of unit pulverizer made it feasible to handle coal with 12 to 15 per cent of moisture. As to the resulting effect on mill performance, it was entirely possible to handle such coal with the ordinary variations in moisture encountered, without any trouble whatever. In such installations variables occurred infrequently and the changes in moisture content were so gradual that they were easily remedied by furnace adjustment. It was his experience that such variables were equally applicable to either the storage or the unit system.

Notwithstanding statements to the contrary, actual experience had shown that the fineness of grind throughout the range of pulverizer capacity was satisfactory for economical operation and that variation in fineness throughout the life of the wearing parts of a well-designed unit pulverizer did not appreciably affect results. Studies of the average power consumption of pulverizers were decidedly in favor of the unit system as compared to the storage system.

A reasonably large furnace was of benefit, but in many installations space requirements would not permit of great furnace volumes. In these cases particularly, the unit system was a solution for capacity and efficiency problems.

Results reported from Ashley Street Station, were as accurate as it was physically possible to make them, and they had been verified by satisfactory performance over an extended period of time. There had been and could be no misunderstanding with regard to this installation for anyone who desired to look into the facts regarding the performance without prejudice.

As to the effect of the double economizer on the Ashley Street tests, the results, as published, specified the actual effect of the economizer, reflected in the temperature rise of the feed water, stating the efficiencies with and without economizer. Incidentally, the temperature rise of the feed water was no greater than ordinarily obtained in regular operation with two boilers on this economizer.

Results at Cahokia Station

Boiler efficiencies obtained on the 18,000-sq.ft. boilers at the Cahokia Station, without economizers, indicated efficiencies of 85 per cent at 190 per cent rated capacity, and 82 per cent at 228 per cent rated capacity. These efficiencies were less than 1½ per cent below those obtained with the storage system, and all indications pointed to the fact that with an improved furnace arrangement there would be no difference in efficiency between the two systems. The ratings in this case were limited by the size of the pulverizers, of which there were two 8,000-lb. machines borrowed from Ashley Street. There was no foundation in fact for the statement that a difference of 6 per cent in efficiency existed between the unit and the storage systems unless reference was being made to equipment at Oneida Street Station that had not been improved during the last four years.

To any fair-minded observer of the developments in unit pulverizers during the last two or three years, it was obvious that many improvements of major importance had been made. In general the trend toward the use of the unit system had been growing and studies of performance, investment and operating costs of the two systems might well be made before continued use of the highly congested, complicated and costly storage-system method of firing was accepted simply because some years ago it was a decided improvement over the stoker installations of that day.

A High-Speed Condensing Turbine for the Small Plant

By C. R. WALLER
Chief Engineer, The De Laval Steam Turbine Company

TO SECURE good economy it is necessary to run a turbine at the highest practicable speed. For small units, this is best done with the aid of reduction gears.

THE rapid growth in size of large steam turbines has been of such marked interest that it has tended to obscure the progress taking place in condensing turbines of small size. The problems of the designer at either extreme are difficult though different in character. With small output the losses become a considerable percentage of the developed power and the question of cost is a much more serious complication than in the case of large machines. Purchasers of small turbines look for economy, but have widely different ideas of its value to them.

At the end of a quarter century of intensive turbine developments, it is still essential to use the highest speed of rotation that is practical. This is shown by increased ratings of the largest turbines at given generator speeds and the more general use of gears with other sizes in order that higher turbine speed may be secured.

A step in advance was taken by the De Laval Steam Turbine Company a few years ago when it designed a special multi-stage condensing steam turbine for ratings around 300 hp. This turbine operates at 10,000 r.p.m. and is coupled to a double helical reduction gear which usually reduces the speed to about 1,200 r.p.m. A number of these machines have been built and placed in successful service.

Fig. 1 shows a section of this turbine and Figs. 2 and 3 show photographs of a unit taken after test. The most striking feature of the design is the three-piece rotor in which the turbine shaft and wheels are integral, the wheels being formed by removing metal from solid forgings. Fig. 1 illustrates how the three pieces of the rotor are fitted and securely bolted together. It will be seen that one piece of the rotor consists of the first-stage wheels carrying two rows of buckets, while

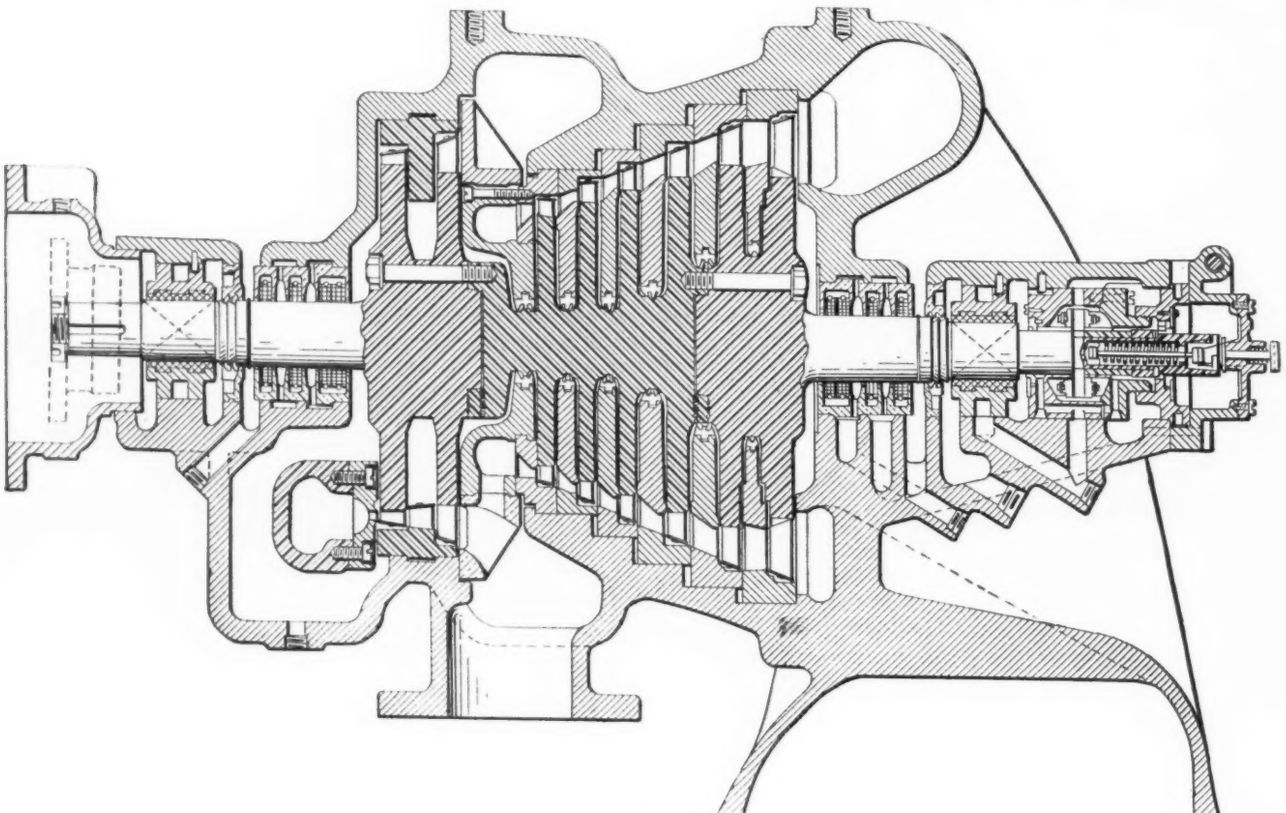


Fig. 1—Longitudinal section of De Laval type DH turbine

the other two pieces supply the disks for six stages, each having a single row of buckets. This construction gives a strong compact rotor free from any chance of wheels coming loose on the shaft and without the need of spacing sleeves between wheels or special means of mounting. It also allows the interstage labyrinth packing to run on the smallest possible diameter, thus reducing the leakage to a minimum.

An emergency governor has been developed which operates with satisfaction at the speed of the turbine shaft. This governor is located within the end of the shaft and consists of an eccentric weight pivoted on a knife-edge and held in place by a spring until the speed is about 10 per cent higher than usual.

The steam chest is separate from the turbine case, but integral with the body of the governor valve. For high pressure or temperature these parts are of steel. Owing to the considerable reduction in pressure through the nozzles mounted on the steam chest, steel is not required for the turbine casing. The steam chest is surrounded by steam at first stage shell pressure, thus reducing the radiation to the room and transmission of heat to the bearings.

Provision is made for a small amount of steam extraction from the first shell if it is desired. The design is such that the first stage requires considerable energy, and therefore the pressure in the first shell is low and the windage loss of wheels and the leakage losses are reduced. At this reduced pressure the volume is sufficient to allow nozzles completely around the first diaphragm, which is of small diameter so as to get proper height of nozzles and buckets.

The design provides well-shielded wheels with the leaving velocity from the single-row wheels carried over to the following nozzles. On leaving the last bucket, the steam enters a carefully shaped stream-line exhaust with sufficient area to prevent appreciable loss between the condenser and the last stage of the turbine. Besides the great care taken to reduce all losses, the nozzles and buckets have been proportioned to give the highest efficiency, and as a result the guarantees shown in Fig. 4 are conservative.

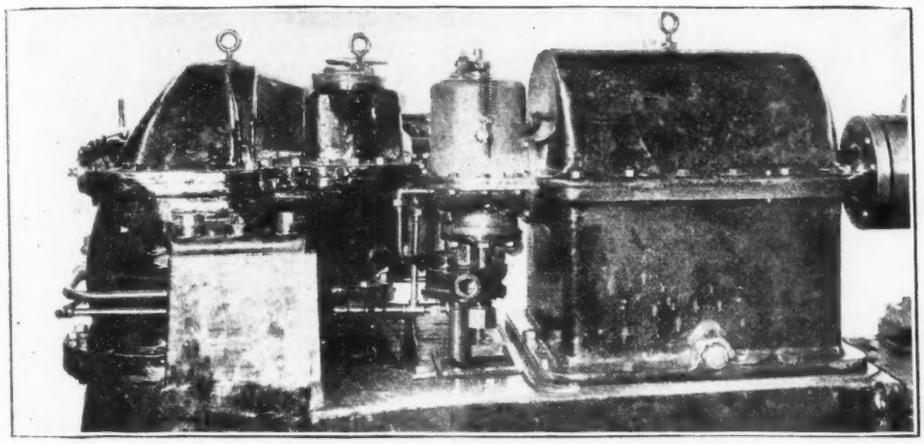


Fig. 2—Steam enters the turbine at the coupling end and exhausts at the outboard end. The operating governor is mounted on a bracket on the gear case, the emergency governor being on the exhaust end of the turbine shaft, as shown in Fig. 1

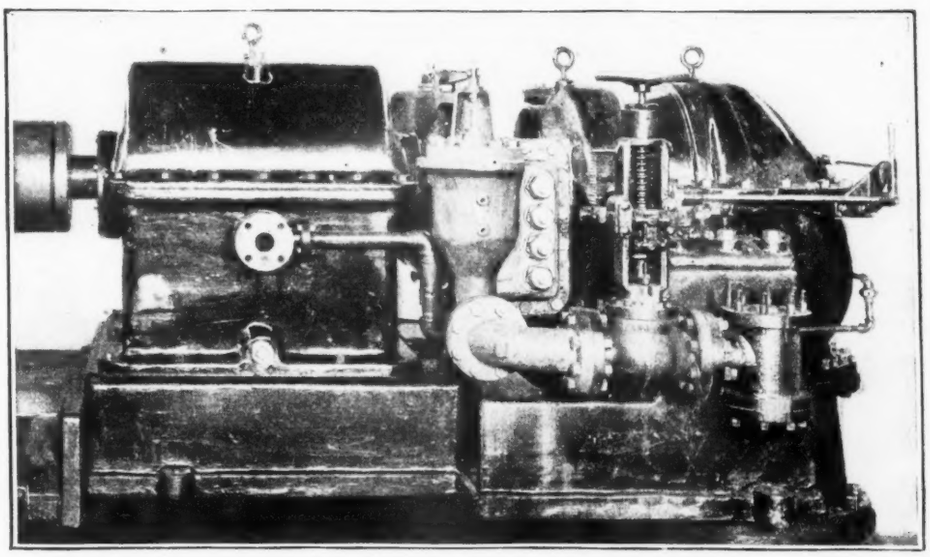


Fig. 3—The steam chest and control valves are on the opposite side of the unit from the operating governor. These, with the internal nozzle ring, are mounted so as to be as nearly independent of the casing as possible, to avoid stress and distortion due to thermal expansion

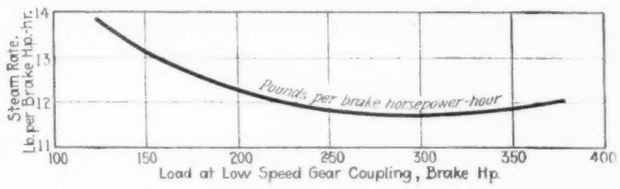
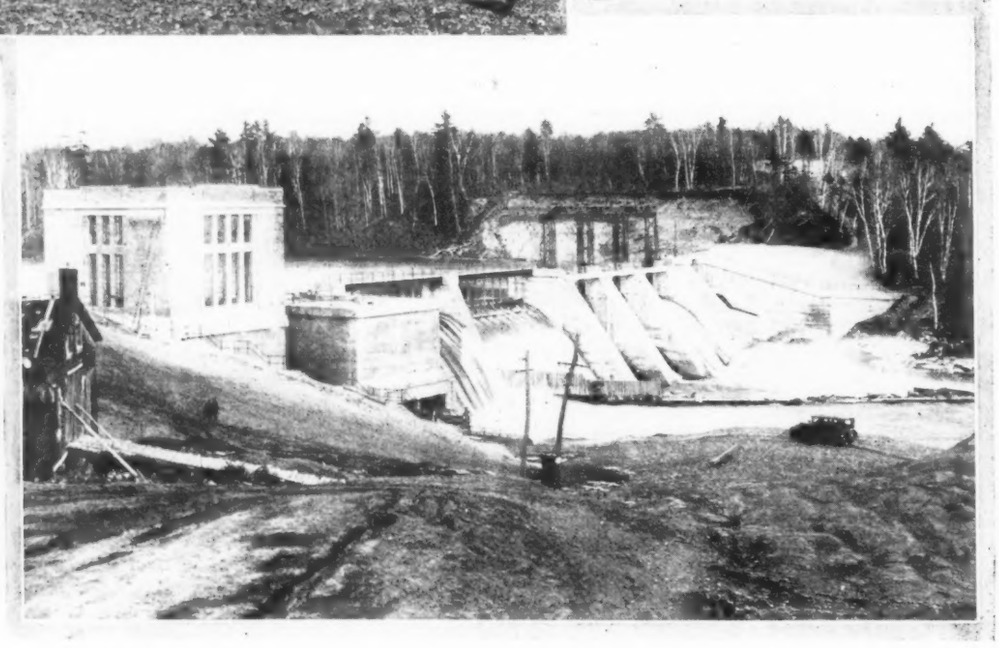


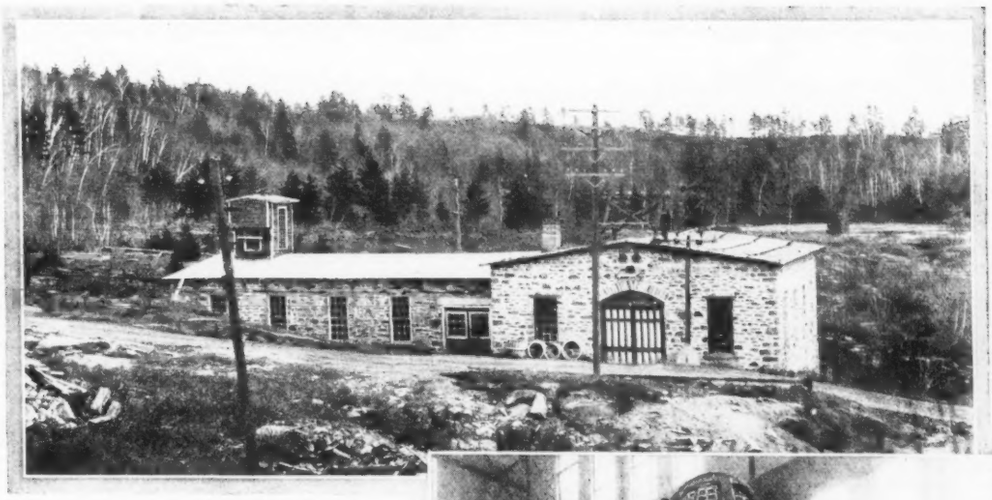
Fig. 4—A typical steam rate curve

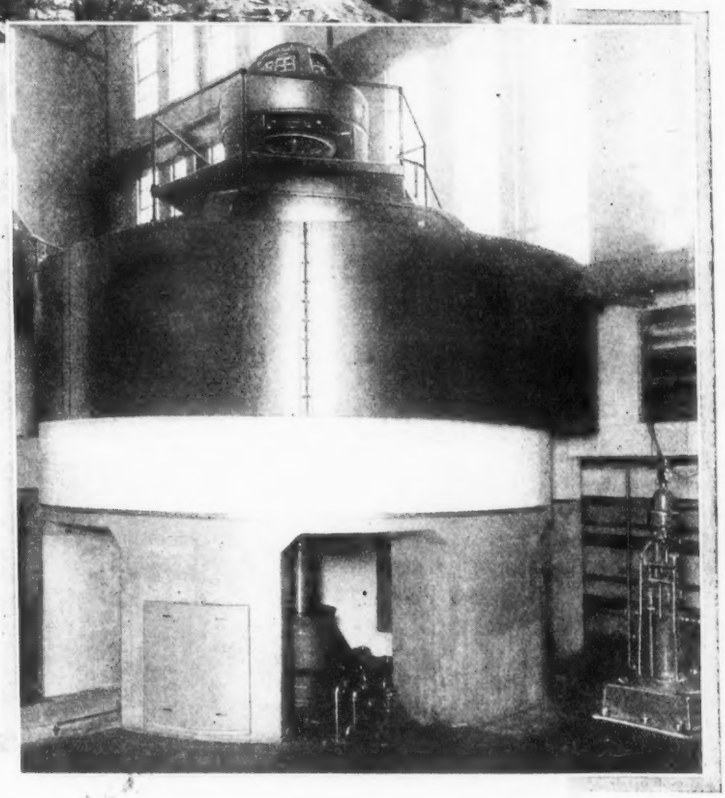
Pressure 200 lb. per sq.in., superheat 100 deg. F., exhaust pressure, 1.5 in. of mercury abs.

Redevelopment of Wat

AT ST. NARCISSE on the Batiscan River, about twenty miles from Three Rivers, Quebec, the Shawinigan Water & Power Company has recently completed a 25,000-hp. plant. This power site was originally developed in 1890 for a capacity of about 1,500 hp. in three units, operating under a head of 80 ft., and the power transmitted to Three Rivers at 15,000 volts over the first high-tension line in the British Empire. At the upper left can be seen the dam for the new development, with the old power house below it. From the dam, a close-up view of which is shown at the lower left, the water for the new plant, shown in the lower right, is carried in a 13-ft. tunnel a distance of 4,200 ft. where a head of 160 ft.

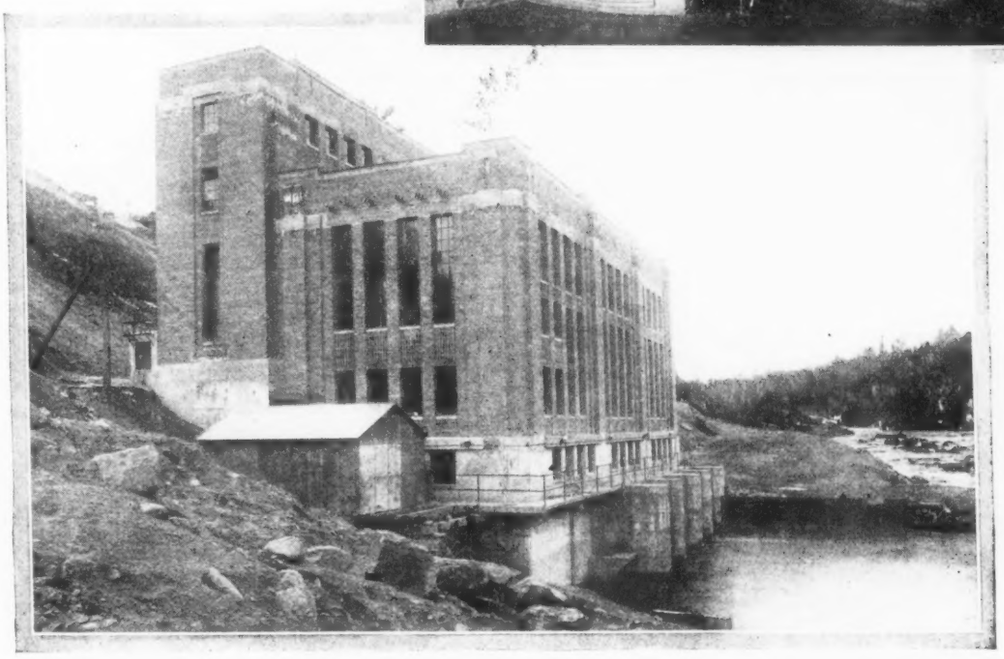






Water-Power Sites

is obtained. The tunnel terminates in a reinforced-concrete surge tank (see center left), from where two penstocks lead down to the 12,500-hp. turbines. An intake for a second tunnel has been provided in the headworks, which will be the same size as the present one and will be built when additional storage is created on the river. When the project is completed, it will have a total capacity of 50,000 hp., where 1,500 hp. was obtained from the old plant, shown at the upper right. As can be seen from the picture on the center right, the new 10,000-kva. generators are supported on concrete pedestals and the operating floor is on the level with the turbine deck.



The Supply of Fuel for Oil Engines

Extent of Oil Underground Not Known—New Fields Discovered Each Year—Most of the Fuel Oil Now Used Uneconomically Under Boilers—No Decided Increase in Price for Decades

By EDGAR J. KATES
Consulting Engineer

IT WOULD be a misfortune for the country if users of oil engines or prospective users were alarmed by the sensational headlines under which the able report of the Federal Oil Conservation Board recently appeared. Many of these headlines gave the impression that there would soon be a grave shortage of oil, which would naturally worry the users of oil engines and deter those who expected to use them. The text of the report, however, clearly shows that no such impression was intended, and the Conservation Board, instead of wishing to retard the use of oil in oil engines, is desirous of promoting its consumption in this manner.

The future supply of oil is an entirely different matter from the supply of coal, iron or other mineral resources, and a numerical comparison between the amounts in sight is meaningless. For reasons that will presently be made clear, we have no right to expect that the oil reserves in wells actually drilled will ever be measured in terms of centuries as in the case of iron and soft coal. The amount of oil actually in sight at any one time is always relatively small compared to the rate of consumption, but this is no reason whatever for concluding that the oil supply will soon run out. Predictions of this sort have been made frequently in the past and have invariably been proved wrong. Ever since 1908 startlingly low forecasts of future production have been regularly issued and have just as regularly had to be retracted because the actual production always far exceeded the estimates.

For instance, by 1924 more oil had been taken out of the Mid-Continent field than David T. Day in 1908 had forecast as the maximum reserve there, and this field is still producing half of the entire country's output. If Arnold's estimate in 1914 had held true, Kansas, Kentucky, Tennessee, Louisiana and Texas would already have ceased to produce. Yet there is today in the Texas Panhandle alone, one field, unknown in 1914, which is producing 150,000 bbl. of oil a day and can produce much more when transportation facilities are available.

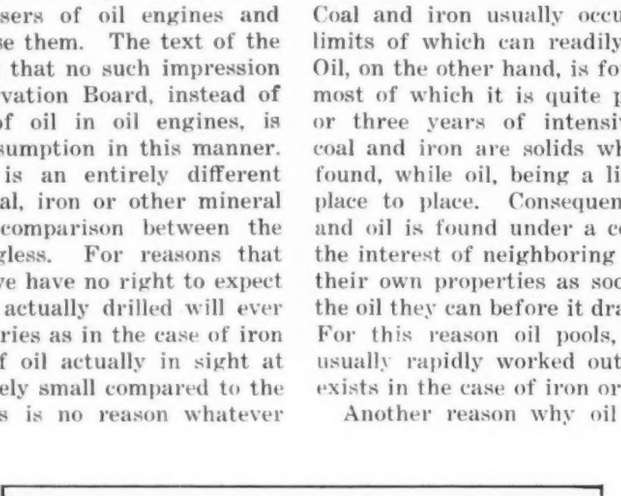


Fig. 1—A gusher in a new Oklahoma field

The reasons why the amount of oil in sight at any one time has no relation to the future supply, are found in the character of the underground oil pools and in the manner in which the oil is brought to the surface. Coal and iron usually occur in enormous masses, the limits of which can readily be determined by borings. Oil, on the other hand, is found in relatively small pools, most of which it is quite possible to drain within two or three years of intensive working. Furthermore, coal and iron are solids which remain where they are found, while oil, being a liquid, will readily flow from place to place. Consequently, when a well is drilled and oil is found under a certain tract of land, it is to the interest of neighboring land owners to sink wells on their own properties as soon as possible and secure all the oil they can before it drains away to the pioneer well. For this reason oil pools, when once discovered, are usually rapidly worked out, whereas no such incentive exists in the case of iron or coal mines.

Another reason why oil fields are not permitted to remain as reserves, is that once a well has been drilled, it costs very little to pump the oil and quickly recoup the heavy investment of drilling, whereas, in the case of solid minerals the expense of extracting and preparing them for the market is relatively high.

It is obvious, therefore, that enormous oil reserves are not at all likely to accumulate and that the 4,500,000,000 bbl. now in sight affords a safe margin. This quantity has no relation whatever to our future oil supply, but may be considered simply as a floating stock to be drawn upon and in turn replenished. A great deal more oil than this will be available when wanted, and this is plainly indicated in the Federal Conservation Board's report.

In the first place, the experience of the past has shown that whenever more oil is needed, new

oil fields have been located. When plenty of oil is being produced, as is the case just now, there is no economic reason for seeking new oil pools. On the other hand, when the need for new supplies becomes great enough, it encourages intensive search which so far has never failed to find new and satisfactory pools. Besides, the continual improvement in geological methods for locating oil has made the "discovery" of new fields an easier matter. Geologists estimate that 57 per cent of the area of this country is favorable to the discovery of oil.

New oil fields are by no means the only source of future supply. Working fields whose limits were supposed to be definitely known have repeatedly been extended both in area and in depth, and have produced much more oil than they were originally thought to contain. The oil lies in certain distinct layers or strata of sand, and by drilling the wells deeper it is often possible to reach other strata from which further supplies may be obtained. The Mexia field in Texas is an example of an oil field brought in by deeper drilling. For years this field produced gas from shallow wells, and finally by deeper drilling a very large production of oil was obtained.

Reworking Old Wells

The report of the Federal Oil Conservation Board calls attention to a potential source of oil of vast importance for the future. This is no less than the securing of a second crop of oil from all the known fields whether they are now being worked or have already been abandoned. That a large amount of oil is now left underground after production ceases with ordinary methods, is undisputed. In fact, experts are of the opinion that only one-sixth to one-fourth of the oil can be recovered by the flowing and pumping methods now employed. Of late, studies and experiments have been made which indicate that additional oil can be forced out of the sands by means of water, air or gas pressure. This was demonstrated in the Bradford fields in Pennsylvania and New York, where the flooding of abandoned wells brought to the surface additional oil equal to 126 per cent of that previously obtained. Some authorities believe that in this way a second crop equal to the first can be secured, which would increase the available reserves by at least 13,000,000,000 bbl.; this would quadruple the amount of reserves previously mentioned.

Coal Distillation

Still another source of oil for the future is the by-product distillation of coal and the distillation of oil-shale. Though the use of coal in this way is still in its infancy, 146,000,000 gal. of light oils were produced in 1925, which in itself is enough to supply about one-half of the oil engines in the country. The oil-shale deposits of Colorado are of enormous extent and contain about one barrel of oil per ton of shale. They form an almost unlimited reserve which will be brought into use when needed.

Future Cost of Oil

Granting that oil supplies will last indefinitely, what about the cost to the oil-engine user? Will suitable fuels for oil engines always be available at a reasonable price? The price question is a logical one as the oil-engine user has in the last few years seen a gradual but steady advance in the price of his fuel. How much farther will the advance go? A study of the situation indicates that the price will rise a little farther, but not much, and the final price will still be low enough to make it highly economical for use in oil engines.

In favor of the modern oil engine is the fact that it uses so little fuel per unit of power developed that a moderate increase in the price of the fuel does not materially affect the cost of power. For example, with the average engine an increase of one cent a gallon in the cost of fuel is equivalent to 0.06 cent extra cost per horsepower-hour, or less than one-mill per kilowatt-hour. The risk of increased power cost from a rise in price of oil is therefore less than that in the coal-rider clauses in most central-station contracts.

Oil Is Used Wastefully

The reason why the price of fuel oil will not advance much more is that at the present time about one-half of all the oil produced by the wells is burned in the form of fuel oil, in furnaces where, if necessary, coal or gas would be satisfactory substitutes. As shown by the chart, only a small fraction of this fuel oil is now consumed in oil engines. As the Federal Conservation Board points out, the three really essential products of the crude oil are lubricating oil, gasoline and other oils for internal-combustion engines. The lubricating-

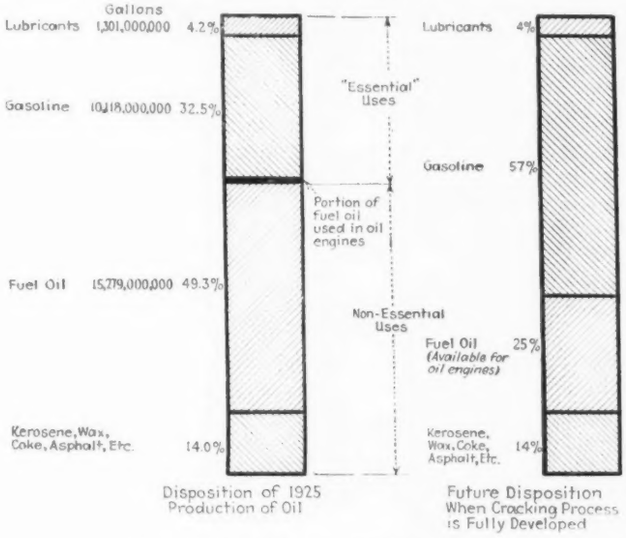

Gallons
Lubricants 1,301,000,000 4.2%
Gasoline 10,118,000,000 32.5%
Fuel Oil 15,279,000,000 49.3%
Kerosene, Wax, Coke, Asphalt, Etc. 14.0%
"Essential" Uses
Portion of fuel oil used in oil engines
Non-Essential Uses
Disposition of 1925 Production of Oil
Lubricants 4%
Gasoline 57%
Fuel Oil 25%
(Available for oil engines)
Kerosene, Wax, Coke, Asphalt, Etc. 14%
Future Disposition When Cracking Process is Fully Developed

Fig. 2—Where the crude oil goes

oil demand is satisfied with only 4.2 per cent of the crude oil, but gasoline takes 32 per cent and the demand is increasing. A few years ago gasoline was obtained from the crude oil solely by fractional distillation, and the proportion of gasoline that any particular crude would yield was fixed, being determined by the nature of the crude. Today, however, the conditions are quite different, as modern cracking processes make it possible to increase greatly the yield of gasoline by taking some of the fuel-oil residue and disintegrating it into gasoline, fixed gas and coke. At the present time about one-third of our gasoline is produced by cracking fuel oil, and the proportion is continually increasing as the demand for gasoline becomes greater.

Oil Too Expensive for Boilers

Thus another great use for fuel oil besides burning it in furnaces has arisen, and as fuel oil is more valuable when cracked into gasoline than when burned as a raw fuel instead of coal, the price of fuel oil has gradually

advanced. It has already reached the point where it is cheaper to use coal in many places, and industrial power plants that put oil-burning equipment under their boilers during the coal shortage of the war period, are now by scores discarding the oil burners and reverting to coal. This has made plenty of oil available for the cracking process and, incidentally, for oil engines. A small further increase in price will cause a great many more oil-burning plants to go back to coal and thus put still more fuel oil on the market. Oil is still being burned on many steamers because of its greater convenience and the reduction in fireroom force, but the author believes that many of these will give up the use of oil either because they cannot compete with motorships which use oil much more efficiently, or because they will have found powdered coal to give the advantages of oil at a lower cost.

Because of the increasing demand for fuel oil to feed the cracking stills, its price has gradually risen enough to cause the needed amount to be withdrawn from boiler use. However, this increase in price will not go much farther for two good reasons. In the first place, a small price advance will give the cracking stills all the oil they need. Secondly, the cracking process itself is expensive, and consequently the fuel oil it uses must be bought at a low price in order that the gasoline produced may be marketed along with the gasoline made by straight distillation from the crude. While it is technically possible to crack 80 per cent of all the fuel oil into gasoline, by re-running the same batch of oil many times through the cracking stills, the cost would be excessive and make it quite unprofitable. The economic limit of the cracking process will be reached, according to authorities in the industry, when half of the fuel oil is consumed in the cracking stills. The other half will continue to be marketed for burning in furnaces and in oil engines.

The Oil Engine's Position

Enormous quantities of fuel oil suitable for use in oil engines will therefore always be on the market, and the price will be an economical one for oil-engine use because the laws of supply and demand will fix it only a little higher than the competitive price of coal when burned in furnaces, which of course is quite low. Based on the amount of heat produced under furnace conditions, oil must sell at about 5c. a gallon to compete with coal at $7 a ton, though a little higher price for oil will be paid because of its greater convenience and its saving in ash-handling.

The amount of fuel oil put on the market in 1925 was about 15,000,000,000 gal., most of which was burned in furnaces. If cracking processes had been developed to the economic limit, there would still have been about 7,500,000,000 gal. available for direct industrial use. The proportion of the available fuel oil that is consumed by oil engines is an exceedingly small one. The best estimates obtainable indicate that the total horsepower of oil engines in this country, both stationary and marine, is about 2,000,000 hp., including Diesel and semi-Diesel, and the annual fuel consumption is about 350,000,000 gal. This is only 2½ per cent of the fuel oil that was marketed in 1925 and 4.5 per cent of what would have been on the market if half of it had been consumed for cracking into gasoline.

It is clear therefore that oil-engine users will always be able to obtain plenty of fuel at a moderate price even when the number of engines in use has greatly increased.

New Rotary Compressor for Supercharging

A new rotary compressor designed by E. Feuerheerd for use especially in the supercharging of internal-combustion engines, has recently been perfected, according to one of *Power's* English engineering correspondents. It is constructed on the principle of rotating vanes attached to a fixed central shaft, the speed of the vanes varying to produce pockets of varying capacity between the vanes. Air is thus drawn into the machine as the pockets increase in size and is expelled in the period during which they decrease.

The objects sought to be realized in the design are compactness and the possibility of running the supercharger at engine speed, up to 5,000 r.p.m. if required. The importance of the latter point is that gearing is avoided and the supercharger increased in the correct proportion to the speed of the engine, so that an engine may have direct-coupled to its shaft a supercharger having an air capacity equal to that of the engine.

Tests have been made with a machine having a capacity of slightly over 200 cu.in. of free air per revolution. The internal diameter of the casing is 7¼ in., and the breadth between the side-covers 3½ in. The external dimensions, excluding cooling ribs, which appear to be unnecessary for low-pressure work, but including cover flanges and provision for ports in one cover, are 9 in. diameter by 6½ in. breadth between the covers. At a speed of about 580 r.p.m. the power required for the actual compression, excluding that absorbed by the motor running light, varied from 735 watts at a pressure of 1.75 lb. per sq.in. to 1,310 watts at a pressure of 4.3 lb. and 1,840 watts at 6.5 pounds.

The Losses in Transformers Vary with their size, frequency and voltage. For example, the iron losses in a 5-kva. 60-cycle single-phase 2,300- to 230-volt unit will be about 45 watts, the full-load copper losses about 100 watts, and the full-load efficiency 97 per cent. For the same size unit designed to operate on a 25-cycle system, the iron losses will be about 70 watts and the full-load copper losses 150 watts, making the full-load efficiency about 96 per cent. When designed for 60 cycles and 13,000 volts, a 5-kva. transformer's iron losses are about 90 watts, the full-load copper losses 125 watts, and the full-load efficiency will be about 96 per cent. These values may vary slightly with different manufacturers and with the age of the transformers. The values given are for modern transformers, but old-type transformers may have considerably higher iron losses, particularly after they have been in service for some time. In modern transformers the iron losses are not appreciably affected by service.

Ball Bearings and Roller Bearings for lineshaft-hanger bearings have not shown completely satisfactory evidence of sufficient power saving to justify their cost. While the static torque is lowered by their use, the running torque and friction load seems to be the same as for good cylindrical bearing with proper oil supply, as would be expected. Ball bearings for special applications have proved very satisfactory, if properly designed, and are particularly applicable to places where cleanliness is a serious consideration.—*George Wrigley in Mechanical Engineering.*

Muscle Shoals Again

ADVICES from Washington indicate that thought is being given to the appointment of another Muscle Shoals Committee.

Unlike several predecessors, this would not be a fact-finding commission, abundant facts having long been available; but it would endeavor to formulate an expression of opinion as to a businesslike course to follow in disposition of the properties. The personnel, according to the plan, would be such as to carry weight with the public as well as with Congress, in which sole authority rests for the disposal of government property.

This latest proposal would appear to have some promise of solution, although the whole background of eight years' incessant wrangle precludes any considerable degree of optimism as to its probable success.

In the first place, to select a group of business men, accustomed to handling large affairs, who are entirely free from entangling business affiliations and independent in thought and action, is in itself no easy task. Assuming that such a committee be found, the chances of its being acceptable to all factions in the controversy are small. On the other hand, a committee made up of men, however eminent, who might be representative of the various interests involved would invite disagreement at the start, even though such disagreement might represent an honest difference of opinion.

When one stops to consider that the maximum primary water power available twelve months of the year at Muscle Shoals is less than half the capacity of the largest steam turbine now on order, the whole controversy appears to have assumed undue proportions.

Meter the Steam by Departments

IT MIGHT be said that it is the operating engineer's sole duty to produce power and steam at the lowest possible cost, leaving their efficient use entirely in the hands of others. This is a questionable policy, particularly as it applies to process steam. Steam is much easier to waste than power. Where it is wasted, coal bills will go up and often, in the eyes of the management, obscure the fact that the coal consumption per thousand pounds of steam is no greater or perhaps has actually decreased. In self-defense the engineer should seize every favorable opportunity to urge the installation of individual steam-flow meters on the lines to each department or group of departments that is a large user of steam.

The mere installation of such meters, with periodical reports of their readings, will often cause the steam demand to fall as much as twenty per cent. If the steam used is actually charged against the operation of the given department instead of being distributed as part of the general overhead, there will be a further substantial reduction in consumption.

Thus the engineer, starting out to protect his own reputation for efficiency, will end up by making large savings for his employer. If the boiler room and power plant are already on a fairly economical operating basis, savings in consumption may easily exceed any possible gain by further improving operation of the plant itself.

Total Heat—Enthalpy

TO CONVERT a pound of water at thirty-two degrees into a pound of steam requires an amount of heat dependent upon the pressure and temperature of the steam generated.

Such amounts of heat are expressed in "heat units" or "British thermal units."

This unit of heat quantity needs precise definition and a name. The terms "heat unit," "unit of heat" and "B.t.u." are not names any more than "length unit" or "unit of length" would be a name for the units that we call inches or feet.

But that is another story!

Returning to the pound of water, part of the heat applied to it goes to increase its volume from that of a pound of water at thirty-two degrees to that of a pound of steam at the given pressure and temperature.

A part of it goes to accelerating the velocity of the molecules in the same way that energy is put into a sling-shot as the sling gains velocity, such acceleration being manifested in the increase of temperature.

A part of it is used in lifting the molecules away from each other against their mutual attraction, as energy would be used when the shot, released from the sling, was projected upward against the attraction of gravity.

This, the amount of heat required to warm up, evaporate and perhaps superheat a pound of water, is called the "total heat" or the "heat content" of the steam at the given pressure and temperature.

But it is objected that this, even for dry-saturated steam, is the sum of three quantities: (1) The heat of the liquid, or the heat required to raise the water to the boiling point; (2) the heat equivalent of the work done in increasing the volume from that of the water to that of the steam, called the heat equivalent of the external work; and the heat equivalent of the work done in separating the molecules, called the heat equivalent of the internal work. And the objectors say that the second of these, the heat used up in pushing back the surroundings to make room for the pound of steam that is being created, is not in that pound of steam or of it and should not be included in what is spoken of as its heat content.

This is more than pedantic punctiliousness. It leads to confused thinking and to serious error, as when one attempts to find the work done by a pound of steam in passing from one pressure to another by taking the difference of the mechanical equivalent of the heat contents in the given conditions instead of the difference in the internal works.

It has been proposed to call this quantity Enthalpy, but it will be as likely to be used incorrectly by one name as by another. The essential is that its meaning be precisely defined and thoroughly understood. Enthalpy, En = in + thalpos = warmth, signifies heat content. Heat content is more suggestive of the continued presence of the heat in the steam than is "total heat," especially if the fact is stressed that total heat means the amount of heat required to make the water into steam, not the heat remaining as such in the steam after it is made. Furthermore, there is the similarity between enthalpy and entropy.

Dished Heads— "Basket" Versus Ellipse

LAST WEEK'S issue of *Power* reported a public hearing on dished heads by the A.S.M.E. Boiler Code Committee. The open-mindedness of the discussion was noteworthy considering that those present represented divergent interests and various points of view. The American Boiler Manufacturers' Association, in particular, is to be congratulated upon the temperate manner in which its representative, P. R. Cassidy, presented objections to any sweeping changes in the requirements at the present time.

He showed that any attempt to force manufacturers to substitute elliptical heads for those of the customary "basket" form profile (large crown arc terminating in smaller knuckle arcs) would mean the scrapping of several hundred thousand dollars' worth of dies. The die situation was shown to be somewhat more complex than might be imagined by one not familiar with the various methods of forming dished heads. It is obvious that the consumer would have to share the expense of this die scrapping. Mr. Cassidy also pointed to statistical verification of the practical safety of heads as now designed in spite of the admitted fact that this design results in high concentration of stress at the manhole and knuckles. The high quality of the metal used, he said, takes care of localized stresses here as it does at rivet holes and tube holes.

At the same time Mr. Cassidy made it clear that the Association would gladly co-operate in further study of the problem and willingly accept any changes actually demanded by the facts of the situation. They merely wished, he said, to avoid precipitate and unwise action. With such a position no sane man can quarrel, and it is to be hoped that additional study will throw further light on certain points where opinions still differ.

There are several such points. For one thing, Is the elliptical profile really the best? Unquestionably, it is superior to the ordinary basket head formed with a crown radius equal to the diameter of the shell and with small knuckle radii. But several German investigators claim that basket heads with radii scientifically proportioned are even better than those of elliptical section. Standardization will be premature until this point is definitely settled.

Another point at issue is the proper shape, location and reinforcement of manholes. Much further study is needed here.

Opinions differ, again, as to the actual safety of heads as at present designed. While it appears that no failures have been reported of heads actually constructed under the Code, there are records of knuckle cracks developing in older heads that happened to meet the A.S.M.E. specifications.

Readers who care to go into the matter in more detail should read the news reports in the issues of January 11 and March 22 and the abstracts of German papers on dished heads in the present issue.

It seems probable that the Code Committee, which is conversant with the various existing views, will so modify the Code as to permit the manufacturer to select his own form of head provided only that he adheres to the particular formula designed to insure practical safety with the profile selected. This would encourage progress without laying an undue burden on the manufacturers.

When the Time Comes To Enlarge

SOUND industries grow. Requirements for power and steam increase. The management, which has been adamant to all suggestions for modernization of the boiler plant, suddenly calls for more steaming capacity and seems willing to pay a handsome sum to obtain it in a hurry. If the engineer in charge is wise, he has seen this storm approaching six months or a year before it breaks. Certainly, a boiler load cannot go on increasing indefinitely without being noticed, even if there are no steam meters.

This warning period is the chance of a lifetime. During it the engineer has ample opportunity to study his equipment in detail and plan just how enlarged capacity can be obtained in a way that will also increase efficiency. When extensions are demanded, the time is ripe to insist upon a complete program of modernization, with properly designed furnaces and firing equipment, feed meters, steam meters, coal scales, pyrometers, etc. The management, under the necessity of making a considerable expenditure for expansion, is then most likely to listen to the plea that a little more money be spent to make it a real job rather than a makeshift.

Fuel Engineering

FIFTY years ago—yes, twenty-five years ago—it would have been considered a good joke to speak of spending a year in college to learn how to buy coal or oil or how to fire a furnace. But the men who laughed at such ideas and scoffed at the school-trained technician, paid dearly for their fun, for they were burning fuel wantonly. Doubtless one-third of their coal was wasted.

The art is advancing. The plant owner and operator alike realize that good operation demands an intelligent, well-informed man in control.

The course in Fuel Engineering recently announced by the University of Pennsylvania is a welcome indication that the needs of industry are attracting the attention of the educator. With a list of fifty men on the staff, including some of the foremost engineers in the country, the course bids fair to be the last word in the training of combustion and fuel engineers.

The course is intended for those with sufficient previous education to insure their effectiveness as students in the scientific field, and with enough practical experience in the preparation or use of fuels to keep their feet on the ground.

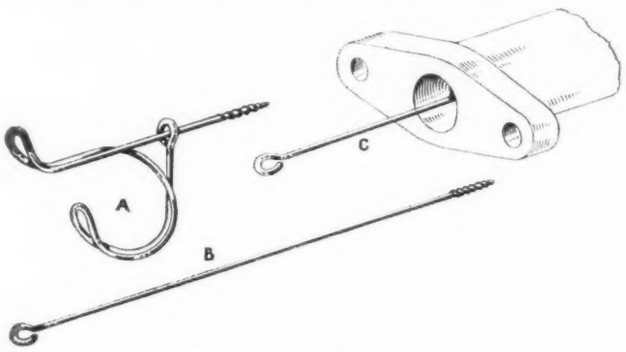
It is a splendid step ahead. Now to find students who look forward with clear vision and see that their advancement lies in the line along which industry must inevitably develop—the fuller utilization of fuel values.

Ideas From Practical Men

Readers are urged to use this department for the exchange of practical operating information. A minimum of five dollars will be paid for contributions accepted.

An Emergency Packing Hook

A serviceable hook for removing old packing from stuffing boxes of pumps and engines can be made by straightening out a common clothes hook as shown in the illustration. These hooks can be purchased in any store for a few cents apiece. When straightened out as at *B*, the threaded end is ready to screw into the old packing and pull it out. While this is an emergency kink, I have found a hook made in this way quite as serviceable as any regular packing hook.



How the hook is made

H. L. WHEELER.
Syracuse, N. Y.

A Flow Meter Suggestion

There are cases where boilers are designed to operate at various pressures, and it is desirable to know the amount of steam the boiler is making when operating under these various pressures. However, the types of flow meters that have been put on the market for measuring the steam output in thousands of pounds per hour, have been designed to record the flow correctly at one pressure, owing to the fact that the flow nozzle constants must be changed when different pressures and different degrees of superheat are used. This was the case in a particular power station I had occasion to visit.

The new electric flow meters which had been installed were designed for 175 lb. pressure and 100 deg. superheat and showed the amount of steam being generated by the boilers when operated at 175 lb., which was the usual operating pressure.

However, two of the twelve boilers in the station were operated part of the time at two other pressures, 265 and 350 lb. It was apparent that these indicating meters were not showing the proper values when operated at these pressures, for in reality the boilers were making more steam at the high pressures than was shown by the meters.

In order to obviate the misconception as to just what these boilers were doing, it was decided to equip an indicating meter with three numbered scales, one above the other. The meter was fitted with a red, a blue and the regular black indicating scale, the last being used for the pressure for which the meter was designed.

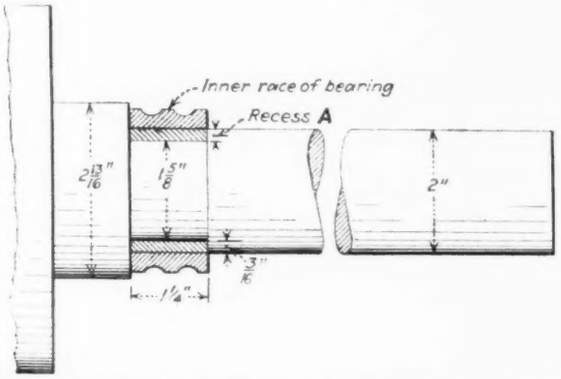
When the boiler is operated at 265 lb., the needle indicates properly on the blue scale, and when operating at 350 lb. pressure the needle indicates the flow on the red scale. The scales were made so as to be already multiplied by the proper flow-nozzle constants. These constants can be obtained in the form of curves from the meter manufacturer.

Schenectady, N. Y. HECTOR J. BEADLE.

Repair to a Worn Motor Shaft

An urgent repair to a motor shaft some time ago caused the writer some quick thinking to devise ways and means to make the shutdown as short as possible. The machine in question, a 25-hp. induction motor, was used for driving a double-throw pump. The inner race of the bearing on the drive side of the shaft had become loose and had been revolving on the shaft, which was badly worn at that point. The inner race, being hardened, was not damaged.

The pinion and the bearing were removed. A piece $1\frac{1}{4} \times 3\frac{3}{8}$ in. was recessed in the shaft at *A*. A piece of cold-rolled steel was chucked and rough-turned on the outside to $2\frac{1}{4}$ in for a distance of $1\frac{3}{8}$ in. The inside was rough-bored to $1\frac{3}{8}$ in. The piece was removed from the lathe and split in two (longitudinally) with a hacksaw. The halves were first filed to make a good joint and then held together and chucked in the lathe again. The inside was finished to within 0.002 in. of the recessed diameter, while the outside was left a shade over the shaft diameter proper. The halves, now finished to the required length of $1\frac{1}{4}$ in., were placed in the recess, and the inner race of the roller bearing was driven into place by slipping a piece of pipe over the shaft and driving it home with a hammer.



How inner race of bearing was tightened on worm shaft

Kamsack, Sask., Canada. JAMES M. BLOOMFIELD.

Flattening Copper Pipe to Make Electrical Connections

In a plant where there was a lot of 1¼-in. copper pipe to be flattened for connection to busbars and switches, a machine for doing this work was made with a hydraulic jack and a die. As shown in Fig. 1, a frame to support the jack and die was constructed with four 1½-in. rods, threaded at each end, and two plates 2 in. thick by 18 in. square. The die is shown closed on the pipe, just before flattening. This die was made in our own machine shop. Its top half consists of a plate *A*, to which is held the anvil *B*. The bottom half of the die consists of a steel plate, to which are attached the two sides *C*, each being held to the plate by two fillister-head screws. At first a 30-ton jack was used to do the pressing, which failed after about two weeks' service, and was replaced by one of 75 tons rating.

The copper pipe treated had walls about ⅛-in. thick and was annealed at the places where it was flattened, usually at the ends. After annealing, the pipe was placed in the die and the jack raised until the load became heavy, when the pipe was removed and again annealed. The pipe was then again put into the die and the jack raised until the top and bottom halves of the die met, which reduced the copper to about 3/32 in. thick. Finishing of the work consisted of checking the

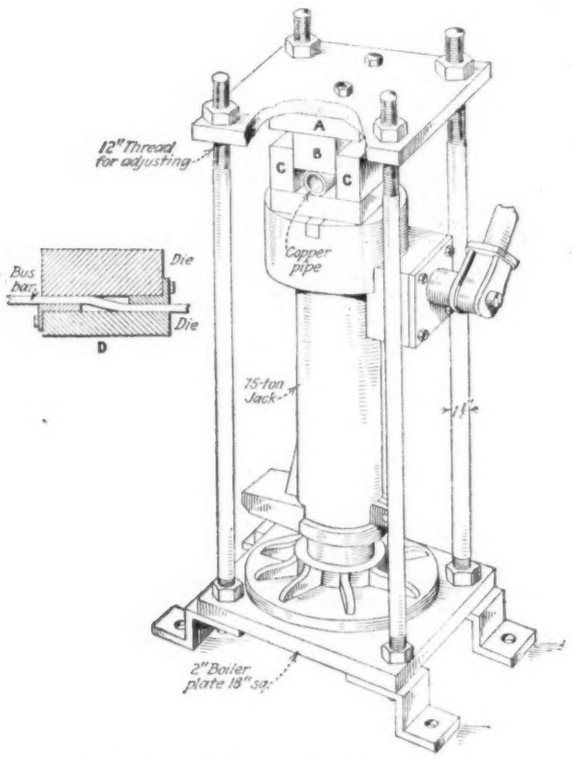


Fig. 1—Jack and die used to flatten copper pipe

flat surfaces with a micrometer to see that they were parallel within 0.003 in. The work was then placed in a vise and the flat part of the pipe tested for straightness with a straight-edge, after which the surfaces were draw-filed to make good contact.

When smaller copper pipe was flattened in the die, a piece of flat steel of the desired thickness was placed in the bottom of the die before flattening the pipe. This gave a uniform thickness to the flat part.

When it was desired to have all the flattening done on one side of the pipe and leave the other side straight, which was frequently the case on the ends of the pipe, a piece of ½x3-in. flat steel, about 16 in. long was placed under the pipe in the die. The end of the steel was made flush with the end of the pipe and the two inserted into the die the desired distance, as in Fig. 2.

When it was desired to make offset jumpers from pieces of flat busbar, a piece of steel of the desired

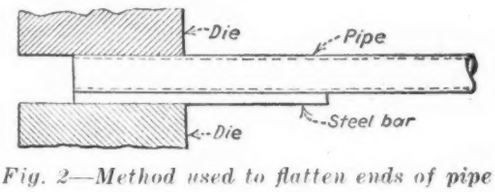


Fig. 2—Method used to flatten ends of pipe

thickness was attached to the top and bottom surfaces of the die as shown at *D* in Fig. 1, and when the jack was raised the results were as indicated.

Holtwood, Pa. G. HENRY ENGLEHART.

"Believe It or Not" in Chimneys

A question that often arises when an old boiler house is remodeled for other purposes, is whether a large power boiler chimney can be utilized for a small heating boiler. In two instances in my experience this has been done successfully. In both cases old power plants had been absorbed in the growth of a larger central-station company. After the power boilers and generating equipment were removed in order to utilize the old stations as warehouses and depots for line construction trucks, it became necessary to install a comparatively small cast-iron boiler to supply the building heating system. In each case a heating boiler was required to supply steam to something like 3,000 sq.ft. of cast-iron direct radiation. Such a boiler usually has a chimney flue about 16x16 in. and 50 ft. high.

At the first plant to be remodeled, there was a handsome field-stone chimney 4 ft. inside diameter and 80 ft. high that it was desired to use. As it was thought that so large a chimney would cause a back draft and fail to operate with such a small boiler, it was originally planned to run a small steel stack up the inside of the stone chimney. The erection difficulties involved rendered this scheme impracticable, and in spite of grave misgivings as to the success of using the large chimney as it was, decision was made to try it out. Much to my surprise, the results were entirely satisfactory.

Later, when the second plant was remodeled, an even larger chimney was available, situated at some little distance from the spot selected to set the heating boiler. Directly above the heating boiler was a portion of the old uptake which had not been removed in remodeling. Suggestion was made that the smoke pipe from the heating boiler be connected into the old breeching, which was about 4x6 ft. at this point. Again with decided misgivings, this suggestion was tried out, and again the result was satisfactory.

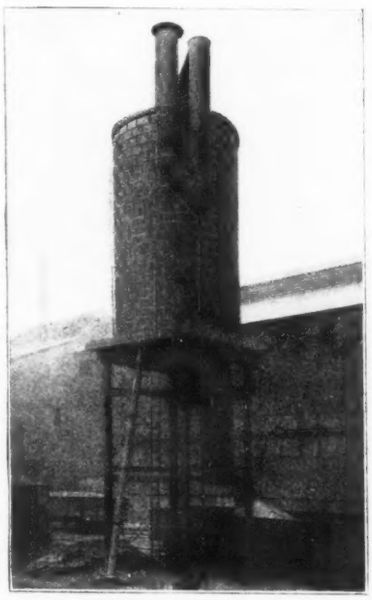
Although the use of these two old chimneys is contrary to generally accepted engineering practice, it turned out successfully in both cases and resulted in a tidy little saving. Possibly the explanation of why the chimneys worked satisfactorily is that they were high enough to offset down drafts due to large diameter.

Buffalo, N. Y. JOHN H. MCKANE.

Comments from Readers

The Steam-Jet Ash Conveyor

I have been interested in the comments on "Steam-Jet Conveyors" which have recently appeared in *Power*. There has been a great deal of misunderstanding and unjust criticism of this method of conveying ash. I say unjust criticism, not because it was not deserved, but because it condemned in principle something that was not wrong in principle, but wrong only in some of its applications. The system appears so simple that companies not possessing competent technical talent or sufficient practical experience undertook the manufacture and installation of this equipment, and as might be expected, the results in many cases were not highly satisfactory.



Conveyor installation with one 90-deg. turn and tank equipped with a wash vent

As simple as the system appears to be, it must be remembered that it is required to convey under varying conditions and layouts in different plants, a large amount of extremely abrasive, corrosive and dusty material and to deliver this material to a receiving bin without dust and in a condition to discharge freely from the bin by gravity. This is a problem for real engineers and for a company that will, in the exceptional cases sometimes met, say to a prospective purchaser, "We do not recommend our equipment for your particular situation."

I believe that all will agree that previous to the last three or four years the faults summarized in the article of E. Hahn in the Feb. 8 issue appeared all too frequently, but these conditions need no longer exist.

Losses due to air leaks are eliminated by the use of flexible gaskets at the joints that take care of vibration and expansion and contraction of the system and maintain at all times airtight joints. Also, leaks at the ash intake ports are prevented by the use of machine-fitted plugs in place of the rough cast surfaces formerly used.

Steam consumption is made moderate by the proper design of the steam-jet fittings and by the correct location and design of the nozzles. It is a lamentable fact that, although full information for the correct design of an efficient expanding nozzle for a particular pressure has been known for many years, even now it is rare to find a correctly designed steam nozzle applied to a steam-jet conveyor. This has caused excessive steam consumption in the past. Also, owing to ignorance, manufacturers have equipped conveyors with much larger nozzles than were required in order to eliminate any possibility of the system's not working.

Maintenance has been reduced by the development of a self-chilling hard white iron. By this I mean an iron of such a composition that, cast up to a thickness of three inches, it will cool and solidify so rapidly that it will be as hard throughout as the surface of iron cast on a chill. It is necessary that the entire pipe and fittings of a steam-jet conveyor give uniform resistance to wear through its entire thickness, and this is obviously impossible where hardness is obtained by casting on chills. While this metal has been greatly improved, its cost has been reduced by quantity production in a plant equipped for the exclusive production of this special metal. Maintenance has been further reduced by the use of quickly replaceable wearing sections designed to have a minimum amount of "not entirely worn-out metal" left when replacement is necessary. In this connection the exterior type of wear section seems logical rather than the interior type concealed within the fitting, which is likely to wear through unnoticed and allow the fitting to be destroyed.

An equally vital thing contributing to low maintenance of a conveyor is the layout of the system. This must be given careful consideration. The system must be made as short as possible and the number of turns reduced to a minimum.

From my experience I must agree with Mr. Alexander and Mr. Brooks that the elimination of dust should not be accomplished by the addition of water into the conveyor pipe if the ashes are discharged into an overhead tank. The amount of water absorbed by the ash will vary, depending upon the heat in the ash when it enters the system and the rate at which it is fed to the system. These are two variables that make it impossible under working conditions to obtain a uniform water content in the ash when discharged into the tank. The most serious result from this is that an excess of water will bind the ash and discharge from the tank can be accomplished only with considerable labor. By all means the ash should be delivered to the tank as dry as possible. The condensation of the steam is sufficient to eliminate any trouble from dust under ordinary conditions where a large vent is used, since the escape of air and steam from the tank is at a low velocity. In cases where the ash is very fine and hot, additional means are required. One method is to vent the tank to the stack or breeching. Another is to use a wash vent. This is a device whereby the escaping air and steam pass through water sprays that wash out the dust. They are devised so that they offer practically no resistance and do not require cleaning.

Even when the ash delivered to the tank is dry, it must be so delivered that it falls slightly and evenly into

the tank and the tank must be provided with large gates to prevent arching. Under these conditions a tank will discharge freely by gravity, and it matters not whether it be flat-bottomed or hopper-bottomed. In my opinion, if these provisions are not made, sloping bottoms and agitators will not give free discharge from the tank.

The illustration shows a steam-jet conveyor installation which has only one 90-deg. elbow. The ashes are delivered to the tank dry, and the dust is eliminated by the wash vent. The ash discharges freely from the gate, which provides an opening of 24 square feet.

In an average installation of an 8-in. conveyor, with two 90-deg. turns, 150 ft. over-all length, the direct cost of steam required to convey one ton of ash should not exceed 12c. per ton and the cost of maintenance should not exceed 2c. per ton. It should discharge the ash into a tank without trouble from dust, without packing the ash in the tank and without trouble from freezing at the gate. Anyone not getting these results should investigate the matter, as they are average, practical figures which are obtainable under daily working conditions with this type of equipment.

Chicago, Ill. EDGAR BRONSON TOLMAN, Jr.,
Chief Engineer, United Conveyor Corp.

Some Uses for Thermometers

Referring to the article on page 261 of the Feb. 15 issue on "Some Uses for Thermometers," it has been my experience covering a number of typical installations that the average measurement of vacuum taken by a properly designed and properly installed thermometer is more accurate than similar readings taken with a mercury column vacuum gage.

The thermometer has several advantages. In the first place, it is not affected by change in atmospheric pressure, as the fixed relation between vapor pressure and temperature as given by the thermometer is the same regardless of the atmospheric pressure. A thermometer with a range of 30 to 160 deg. F. with an expansion chamber at the top of the tube large enough to take care of a maximum temperature of 260 to 300 deg. to prevent damage in case the turbine operates non-condensing, is a much more accurate operating instrument than the mercury column provided it is properly designed and properly installed. A thermometer of this kind can be easily read to a half degree or less, which is equivalent to reading the vacuum to 0.02 in., an accuracy difficult to obtain with the ordinary mercury column.

The only error introduced in reading a thermometer would be due to either an excessive amount of air in the turbine exhaust or superheat. With a steam flow of 100,000 lb. per hour and an air leakage passing the thermometer amounting to 5 cu.ft. per min., the error would be much less than 0.005 deg. which is equivalent to 0.0002 in. This is an excessive amount of air to be present at the turbine exhaust. Superheat in the exhaust is present as a rule only when running under light loads, and the readings taken at such a time do not represent the average operating conditions, nor are they of such great importance.

It is essential that the thermometer be properly insulated so that heat from the stem is not conducted to the exhaust casing of the turbine and also that the bulb be located where an average temperature indication is obtained. As a rule there is no great difficulty in properly locating the thermometer.

In many of the large power stations at the present time the thermometer is relied on entirely for operating and the vacuum gage is merely used as a checking instrument. The results of these checks have shown that the thermometer readings can be relied on.

Rochester, New York. J. W. SCHWARZ.

Steam Power from the Ocean in the Tropics

I have been much interested in R. H. Andrews' article in the March 1 issue on "Steam Power from the Ocean in the Tropics." The first article I saw on this project was in a Sunday newspaper supplement. I supposed it was simply another of the fantastic schemes that fill space in the newspaper supplements without doing anyone any harm, but then I saw it discussed in an otherwise rational business magazine, and next in engineering periodicals. Nobody seems willing to do anything more than express mild skepticism, because of the standing of the authors.

Most of the engineering snags that would be run into have been pretty thoroughly discussed. The problem of air effect and air removal, while it has been mentioned, has not been touched on carefully. Water at 82 deg. F. contains practically ½ per cent oxygen by volume, volume of gas being measured at standard conditions. Dissolved nitrogen amounts to almost twice this amount, giving a dissolved gas content of 1½ per cent by volume.

Mr. Andrews assumes that 250 lb. of surface water per pound of steam would be used in order to keep the steam temperature as near 82 deg. F. as possible. But wouldn't the use of such a large ratio defeat its own purpose by introducing such a large volume of air that the consequent temperature lowering would be serious? Of course, not all the air dissolved in the 250 lb. of surface water would be liberated in the steam generator, but a large portion of it would, and it seems to me that the partial pressure of this dissolved oxygen and nitrogen would so reduce the temperature range as to cut a large slice out of the effective power output.

But suppose we assume, for the moment, that steam mains of 120-ft. diameter are perfectly feasible and can easily be kept leakproof; that turbine rotors of 90-ft. diameter can be commercially built, shipped to the tropics and easily erected, to say nothing of running with a reasonable friction loss; that condenser-water intake pipes of 25-ft. diameter can be thoroughly insulated, protected against pressure and corrosion, and easily lowered into the depths and readily anchored to a steep slope at 3,000-ft. depth; and that the current output of the plant can easily be sent out by radio transmission. We will assume all these details.

Where is the market for all this something-for-nothing power? Who is going to use it, and what are the consumers going to make with it? What kind of a manufacturing center is going to be built up within a short distance of this power plant, to take the output? In this country public utilities that contemplate the investment of 25 or 50 million dollars in a power-producing enterprise usually do some preliminary figuring to make sure there will be a demand for the product. Any new large-scale manufacturing proposition has to consider this matter of sale of the product.

The saying is that industry goes where power is plentiful and cheap. But I can't quite picture industry flocking to the Tropics in the wake of this power sup-

ply, which would hardly be cheap. The investment required would be so tremendous that fixed charges per kilowatt-hour of net output would be prohibitive.

The best example of the fallacy of universal application of the idea that industry follows cheap and plentiful power is that Africa is dotted with waterfalls that offer golden opportunities for free power, and yet only a small portion of them have been developed or are likely to be developed within the next hundred years. Why? Because the disadvantages of location, transportation, etc., far outweigh the advantages of cheap and plentiful power. And certainly an undeveloped African waterfall should offer no impossible engineering problems.

It seems to me that this is one of the most fantastic and ridiculous engineering projects that has been seriously proposed and discussed for a long time. The fact that its sponsor is a scientist of world fame and of undoubted genius does not make it any more plausible. If it had been suggested by an operating engineer, he would have been greeted with pitying glances and perhaps invited to occupy a well-padded cell. But when the plan originates with a well-known scientist, it gets a hearty reception.

W. J. RISLEY, JR.

North Glenside, Pa.

For Better Co-operation in Power-Plant Purchases

There are different opinions and preferences that govern purchases for the power plant, and products as finally received do not always meet with the approval of the engineer. The purchasing agent may contend that materials are being ordered to the best interests of the plant, and he may have his own facts to go by. How about the engineer? Does he ever, independently, maintain some form of record-keeping, so that he can show, in black and white, just why his views should command greater recognition? Would not such a record afford a certain assurance to the engineer, serving as guidance to still better purchases?

Let us illustrate possibilities. The record book should concern the matter of inquiries relative to purchases and replies and other relevant data should be entered when products finally are ordered. There should be enough space for all important information regarding individual purchases, how bought and when delivered. Perhaps in some way the engineer may have disapproved of certain of the products; this, too, can be jotted down.

Other information might be recorded also, regarding results following the use of different materials. If any important experimentation has been under way, such a record book would be of value, since it would enable the engineer and his assistants to ascertain given results attending the use of any product. There would be little room for guesswork.

Now, how does such a book work out when questions again come up concerning contemplated purchases? Here, indeed, the book should play an important part. The engineer can consult with the purchasing department, and now as he has facts himself, the purchasing agent is reassurred. Such a simple form of record-keeping would help the entire plant.

Nothing elaborate is necessary, and an assistant can take care of the book quite well. Many times the engineer would like to find out concerning some firm that had been previously written regarding proposed purchases. Perhaps no reply had been received. Perhaps the firm took its good time to offer quotations. The engineer may not have given an order before, but he wishes to do so now. Thus, access to his ever-handy record book would help solve one of his worrisome problems; it would give him information many times that would eliminate the necessity of further inquiries.

The book would indicate just what sort of service had been received from different selling firms from time to time. This would pertain to packing, shipping of products, which would be apart from the results and value of the products themselves; and there may be remarks regarding interest shown and service given following purchase. Apart from insuring better co-operation between the engineering staff and the purchasing department, the book would serve as inspiration to wiser and more satisfactory purchases. The engineer would know to a nicety just why he should order materials for the power plant.

Brooklyn, N. Y. FRANK V. FAULHABER.

Cracks in Plastic Refractory Furnace Lining

The letter of R. McLaren on plastic furnace linings in the Feb. 8 issue raises a point that contradicts my experience with plastic linings. I am a busy engineer, and I do not often have time to write letters for publication, but in this case I feel it my duty to comment on Mr. McLaren's letter.

He writes about shrinkage cracks, stating that they prevent a monolithic wall from being really monolithic and that they weaken the wall. This is not my experience. I have yet to hear of a plastic installation where cracking caused any serious trouble. I do not know of any plastic wall that has ever been undermined or that has bulged and fallen in.

It is true that after the initial vitrification, some cracks have appeared perhaps one, or at the most two, to a wall. The first time the boilers have come off the line, I have had these cracks grouted up and they do not reappear. I cannot see where these cracks decrease the life of the wall in any way, particularly when I have found that the use of a monolithic lining increases furnace life considerably. It is my opinion that these cracks need not be grouted up, although this has always been my practice. I really believe that these cracks disappear when the furnace goes back into service and when the walls expand as they are heated.

I have never been certain that the cracks were caused by shrinkage because in a good plastic firebrick shrinkage is negligible. I have often thought that they were caused by the difference in expansion between the common brick and the refractory lining. Everything expands when it is heated. This is as true of a monolithic wall as it is of a firebrick wall. In a firebrick wall this expansion results in the breaking of the joints. I believe that in monolithic walls the movement of the wall under expansion has caused the cracking that Mr. McLaren writes about.

If he will buy a good plastic firebrick that has been thoroughly preshrunk in manufacture and install it properly, following the directions of the manufacturer, I am sure that he will find that shrinkage is negligible and not the cause of annoyance. That has been my experience with plastic linings. At the central heating plant where I am chief engineer, we have monolithic linings under six 5,000-sq.ft. boilers.

Chicago, Ill. WILLIAM G. ALTON.

The Use and Economy of High-Pressure Steam Plants

By PROF. A. L. MELLANBY and PROF. WILLIAM KERR

THE rapid strides of steam-plant design makes us wonder just when and where the limit will be reached. The developments of the high-pressure steam plant have, in the last ten years, advanced at a staggering rate. Within the last decade pressures have mounted from 250 to 400, to 600, and even to 800 and 1,200 lb. per sq.in. In the near future, we are told, there will be plants using steam at 1,500 and 1,800 lb. per sq.in., while experiments are being made on even higher pressures. Superheat has made its strides too. Ten years ago 600 deg. was high, but today the modern plant uses 750 deg. and there are one or two isolated plants using as high as 800 or 900 deg. Generating units have grown from 15,000 kw. to 50,000 and 60,000 kw. with the report of one with a rating of 208,000 kw. Boiler design has developed even faster. The generation of steam in quantities of 300,000 lb. per hour is neither impossible nor untried. Condensers and condensing equipment have easily kept abreast and met all requirements.

With the demands for electrical energy mounting far more rapidly than the nation's water power can be exploited, developments should continue at a stimulating rate. Construction of steam plants will call for the highest type of design embracing all the most effective means of reducing the cost of production of power, among which is the generation of steam at high pressures and superheats. There are, however, problems that are yet to be solved by the metallurgist, the chemist and the equipment designer.

Problems to be Solved

One of the gravest problems to be overcome is the application of materials to these extreme steam conditions. It represents the main factor limiting the boundaries of ultimate achievement and the main hindrance of the advance to that goal. Because of the weakening influence of high temperatures on materials, high pressures and superheats increase at a very rapid rate the severity of conditions to which these materials are subjected.

The quality of resistance to corrosion and erosion must always be considered in the selection of materials for steam-plant application. The present high degree of resistance attained for moderate steam conditions must be maintained. There are many phases in the study of the relationship of materials to high pressures and superheats—far too many to discuss here. But there is one phase to which attention should be called. It has been shown that a hot boiler tube, above certain temperatures, renders a slight dissociation of steam with the evolution of free hydrogen, and presumably oxidation of the metal. If this condition proves to be fundamental, then a problem of some magnitude is presented.

Many notable changes have occurred in boiler practice. The idea of high unit powers seems to have created the ambition of a single boiler-turbine-condenser system and, although this is not actually achieved, the advance in the mere size of the boilers has been most striking. But such an advance was always open to the designer, and this advance is not a resulting necessity of high-pressure generation. It is only the outcome of intensive developments in all directions that have been brought about by the demands for higher economy.

THIS brief abstract indicates what these British engineers said in a paper read on Jan. 21, 1927, before the Institution of Mechanical Engineers. The full text appeared in *Engineering* (London) for Jan. 28, 1927 (page 117) and Feb. 4, 1927 (page 149). The original paper includes detailed data on the properties of metals as affected by high temperatures, on the stresses set up in boilers and superheaters, and on the influence of several factors on the efficiency of various thermodynamic cycles.

The most direct effects on boiler design made by the demands for higher pressure are shown by three new methods of steam generation that have appeared in actual operation within the last few years. These are the Benson "critical-pressure" boiler, the Atmos "revolving-tube" type, and the Löffler system. Each endeavors to overcome in a different way the troubles encountered when generating steam by violent boiling.

These new methods are ingenious and are, in a sense more notable developments of the period than are the elaboration and perfection of standard practice. But they have hardly yet affected boiler methods.

Our immediate concern is the hindrances to pressure advance, and none of these methods really promises any help for this difficulty. These difficulties are seen in such prime requirements as pure feed water and the reliability of materials.

The feed-water problem increases as the operating pressure and superheat rise. The solubility of scale-forming substances decreases with the rise of temperature, so that they must be reduced or eliminated by treatment. Even though evaporated makeup is used, a slight leakage in the condenser is sufficient to create trouble.

The pretreatment of feed water to remove hard scale-forming bases without introducing harmful gases into the steam is another problem of some magnitude. On the other hand, the proper removal of these gases from the condensate is an engineering operation largely met with closed systems and air-removal equipment. The joint use of all such methods seems to lead to satisfactory results, and it is highly probable that any required degree of perfection to safeguard the boiler elements can be attained for any pressure or temperature that is not limited by the problem of suitable materials.

With large turbine units, operating under moderate steam conditions, there has always been the problem of exhaust losses. With the use of high-pressure steam there appears at the intake end of the turbine a difficulty that must be overcome. The turbine outlet demands a passage to accommodate steam in very large volumes, whereas the intake must be designed to handle very dense steam in small passages. The outlet problem has led to a multi-exhaust system; and the inlet problem leads to a separation of the turbine sections so that the high-pressure steam may be dealt with in a small compact cylinder suitable in size and design to the extreme density and the high temperature of the steam at the inlet.

The materials of such a unit must be able to withstand fair stress at high temperatures; but generally the proposed operating temperature is a clear indication of the severity of conditions since it should be possible to design for the same stresses at all pressures.

Effect on the Industrial Power Plant

In the case of the smaller industrial plants there are circumstances different from those of the plants primarily engaged in the production of power. The industry may be one that has large quantities of waste heat—such as steel and iron works—with which it may generate its power; or the industry may be one in which there is a need for a great quantity of low-pressure steam for heating, drying and other processes and may use the steam for generating power before it passes to the essential duties. These problems are met with the ordinary turbine in conjunction with a special waste-heat boiler for plants in the first class, and a combination of an ordinary boiler and a special bleeder turbine for the plants in the latter class.

The conditions in process plants are varied, but if the use of high-pressure steam proves successful, they can show a relatively higher gain than the central station operating on the same steam conditions. The economies of high-pressure steam increase as the plant back-pressure increases, and since all heating systems are back-pressure systems, the margins that may be used in calculating the gain due to the production of power are correspondingly enlarged.

In the process plant large quantities of steam are used, but the uses to which it is put require only a low pressure. The difference between this low pressure used in the process work and the higher pressures considered in power projects can be used to produce byproduct power. And, too, in a high-pressure plant steam could be tapped from the power unit over a much wider range of conditions. Even processes requiring a higher temperature and pressure than usual could take their steam from what would be the lower stages of the turbine. If higher steam conditions can be used in the established low-pressure methods, the size and the cost of the plant might be greatly reduced.

The question of costs will always exercise an important influence in industrial power plants. But the relation of the thermal economy of the industrial plant is entirely different from that of the central station. Since the heating process is the essential function, high fuel economy is assured by using the latent heat for that purpose. Therefore the use of steam at the higher pressures and temperatures will increase an already high figure of economy. Proper appreciation of the merit of the high-pressure plant depends upon proper accounting, that will credit the heating plant with a gain through the production of power rather than consider the power plant as losing through heavy extraction for process operations. The accounting requires a proper understanding of both the thermal and the commercial aspects of the industry. In this type of plant the arbitrary judgment of the individual and the existence of fully depreciated plants, introduce factors that tend to confuse the thermal and simplify the commercial factors.

The industrial plant may, then, prove slow to benefit from new practices, and because of the many and confusing conditions, it is unlikely that it will ever use the highest pressure and temperature values and the elaborate design of the subsequent equipment. But although the effort has hardly begun, the scope is quite clear and the promise conspicuous.

Inspection and Maintenance of Automatic Station*

INSPECTION of automatic stations requires for its complete comprehension a definite knowledge of the service the station is expected to give. The average station requires a general inspection at frequent intervals and a detailed inspection at longer intervals.

A general inspection is, as its name implies, a cursory review by an inspector of the station and its equipment. The frequency of these inspections will depend upon the size and service importance of the station. Important stations, such as those feeding large urban and even some interurban loads, should be visited daily. Less important stations, such as those feeding the usual interurban trolley lines and small and moderate-sized mines, industries and towns, may be visited weekly. The still less important stations, such as those used for sectionalizing or feeding small loads, may require general inspection only at monthly intervals.

During a general inspection the inspector should glance at each piece of equipment in the station, make note in the station log of the readings of all operation counters, and if necessary make minor adjustments in devices that require such adjustment. No really definite program can be given that will cover a general inspection of all kinds of automatic stations. Experience has indicated that a few months' training will give the usual inspector sufficient skill to know which pieces of equipment require attention from time to time and where it is necessary to look in anticipating faulty operation. Of prime importance is a record of each such inspection with the observations that have been made during the course of the inspection. These should be recorded in the station log book, which should always be kept in the station.

Detailed inspection, as its name implies, is a thorough inspection of the station and its equipment. The frequency of such inspections will vary from one a month for important centers to one a year for less important stations. The thoroughness with which detailed inspections are made depends upon the service the station is called upon to give as well as the frequency with which it operates.

Sequence of Operations

One feature of all detailed inspections, however, should be a careful check of the sequence of all operations that the station is designed to perform. This will serve to indicate if any device is failing to do its assigned duty in the prescribed manner.

Other features of all detailed inspections should be to insure all nuts, bolts and connections being tight, spring cotters opened, contacts clean and not overheating or burned, current-carrying parts of the equipment in good operating condition, etc. All relays and similar devices provided with adjustments and calibrations should have these adjustments checked to be sure the devices are set to operate within the prescribed limits. For devices such as relays operating on small currents, a semi-annual check of the setting is of benefit to insure best operating performance. For series devices carrying large currents, a check of the settings may be made as local conditions permit or require.

Detailed inspection should not be made a burden or a costly procedure by including in it too much detail. There is always a limit. For example, if a circuit breaker is to be given a detailed inspection, one might completely disassemble it and then reassemble it and in doing so, might harm this piece of equipment. On the other hand, if it is partly disassembled so that the moving parts can be cleaned and lightly lubricated, then it is of distinct advantage. So with this as an example, it may be seen that as with the testing, detailed inspection requires study on the part of the operating company engineers in order that it may provide a maximum benefit and yet be done with minimum expense.

Maintaining the Equipment

Maintenance of automatic stations is second only in importance to their inspection if the best service is to be obtained. The amount of maintenance required varies through wide limits depending upon the equipment, its adjustment, its application and what it is expected to do. Included in maintenance is the periodic cleaning of the station and of the individual devices and pieces of equipment in it as well as the replacement of parts after fair wear and tear in service. In addition it includes a great many details required to keep the equipment in good operating condition. For example, the oil in the bearings of rotating machines should be changed as occasion demands. When the station is subjected to extreme temperatures at various seasons of the year, oil for the bearings should be so selected that it remains fluid throughout the temperature range experienced and still gives the required lubrication. This may seem a little detail, but it is one of the many which differentiate between failure and success in operating automatic stations.

Automatic Station Costs Low

Many other examples could be given, but of course these are obvious to the operators of automatic stations. It should be noted, however, that the simple stations, those for example having only feeders, require very little, if any, maintenance, while the largest and most complicated automatic stations require even less maintenance than do manual stations of the same size.

The frequency of maintenance depends solely on local conditions. Some automatic stations have been known to run for years with almost no maintenance expense. Others seem to require the frequent visits of maintainers. As an average, however, reports from many sources have indicated that the usual automatic station costs only about three-fourths as much to maintain as does the equivalent attended manually operated station.

*Abstract from a paper, "Testing, Inspecting and Maintaining Automatic Stations," by Chester Lichtenberg; presented at the regional meeting of the American Institute of Electrical Engineers, held in Kansas City, Mo., March 17 and 18, 1927.

German Studies Throw Light on Dished Heads

THESE studies indicate that properly proportioned "basket"-shaped heads are even stronger than those of elliptical section, which in turn are much stronger than basket heads of ordinary design.

JUST now the spotlight of engineering analysis is being thrown on the subject of dished heads for pressure vessels. Interest in this matter was revived by the series of papers presented at a combined meeting of the A.S.M.E. and American Welding Society in New York on January 4.[1] The papers there presented contained experimental and theoretical material to show that the customary design of a dished-head contour as an arc having a radius equal to the diameter of the tank and connected to the tank by knuckle fillets of small radius is without rational foundation. The speakers at that meeting concluded that a properly designed head should be elliptical in section.

This renewal of interest led the Boiler Code Committee of the A.S.M.E. to hold a public hearing on March 17 to gather expert opinion on the various phases of the problem. A report of this meeting was given on page 46 of the March 22 issue of *Power*. Mention was made there of two German papers, abstracts of which were read at the meeting. These papers were in accordance with those presented at the Jan. 4. A.S.M.E. meeting in concluding that the elliptical shape was decidedly superior to the basket head of common proportions. Both of the German papers, however, claimed that proper adjustment of the radii could make the basket head somewhat stronger than an elliptical head of the same depth. Summaries of these papers follow.

Doctor Otte Defends the "Basket" Head Profile

An article by Dr. Ing. Wilhelm Otte in the November 30, 1925, issue of the *Zeitschrift des Bayerischen Revisions-Vereins*, sustained the thesis that the elliptical profile of dished heads is not the best. Dr. Otte suggested that the head profile should be that of a "basket"; that is, the customary approximation of a half-ellipse, consisting of a large-radius crown arc connected to the cylindrical portion of the tank by knuckle arcs of smaller radius. With the same ratio of long to short axis, he pointed out that the basket shape gives a larger knuckle radius and a smaller crown radius. The following paragraphs constitute a brief abstract of Dr. Otte's paper:

This discussion is concerned only with unstayed dished heads having the pressure on the concave side. It has been the custom to design such heads on the assumption that the head is stressed as part of a hollow sphere having the same radius as the body of the head. This assumption is based on the further assumption that the flange radius is large enough to insure a gradual transition from the crown to the cylindrical part at the circumference of the head.

No rational basis has been developed for determining the proper radii for crown and knuckle. As a result of numerous accidents, indicating that existing standards were unsafe, Klöpper's proposals, prescribing that the radius of curvature should not be greater than the inside shell diameter, and that the knuckle radius should be, as a rule, at least one-tenth of this, were used as the basis of preliminary official regulations.

This ruling shows progress, but the question is by no means closed, and it would be regrettable if the shape of heads were to be fixed legally before the definite clearing up of these conditions. Recent experiments by Bach have proved that heads of elliptical section and with a ratio of two to one for the main axes (depth of head one-quarter the diameter) are about four times as resistant as the heads hitherto used and about twice as resistant as the Klöpper heads.

Attention, however, must be drawn to the fact that the elliptical form is not, as such, the cause of increased strength, as might be concluded from Bach's publication. It is due entirely to the more favorable dimensions of the crown radius and the knuckle radius, for the chosen ratio of the axes. Generally, at a given ratio of depth of head h and diameter d, that form is the most favorable in which the crown radius r_1 is a minimum and the flange radius r_2 is a maximum. But, as will be gathered from the following, an ellipse does not meet this requirement.

If we take the ratio of the main axes, such that the depth of head is one-quarter the diameter d, it may be calculated that r_1 equals d and r_2 equals $0.125d$ for an ellipse.

For the same case, where h is equal to one-quarter of d, the best proportions of a basket profile are as follows: r_1 equals $0.9048d$ and r_2 equals $0.1726d$.

Here the crown radius is 9.52 per cent smaller than in the case of the corresponding ellipse. On the other hand, the knuckle radius is 38.1 per cent larger. This larger knuckle radius favors the basket curve over the ellipse.

Tests Made on Dished Heads at the Kaiser Wilhelm Institute

The following is a brief summary of a report made by Erich Siebel and Friedrich Körber on experiments made at the *Kaiser Wilhelm Institute fur Eisenforschung Zu Dusseldorf* to secure evidence as to the effect of manholes on the behavior of boiler heads when under internal pressure. The report also discussed results of previous experiments on the strength of dished heads without manholes

The investigation made by the writers may be outlined as follows: (a) measuring the elastic deformation perpendicular to the surface and determining inception of permanent deformation as well as the permissible test pressure for measurements under *b* and *c*; (b) measuring the changes in curvature; (c) measuring the dilatations of the surface; (d) measuring the permanent deformations and observing flow phenomena; (e) measuring elastic deformations after previous strong permanent deformation.

[The discussion of the methods of testing used and the results obtained, as given in the original paper, is rather technical. Moreover, the conclusions reached are highly complex, involving a great number of factors. It is, therefore, impracticable to do more here than indicate in a very general way the main trend of the conclusions.—Editor.]

The conclusions reached from the study may be summarized briefly as follows:

1. Strains in heads without manholes are due in the first place to stress maxima appearing in the direction of the meridian at the inside of the knuckle and at the outside of the main curvature. These are caused by strong bending loads, due to curvature changes in the meridian curve. Heads of elliptical shape, and those of basket profile closely approaching the elliptical form, show the lowest stress values for a given depth of head.

2. In manhole heads, extraordinarily high stresses occur at the manhole edge, far surpassing the maximum stresses in corresponding heads without manholes. Heads developed with a protruding manhole edge show a considerable reduction in edge stresses and deformations.

3. The deformation of the heads is in agreement with the stresses described. At the knuckle the elastic line always has a strong negative curvature, corresponding to the high bending moment existing there. At the edge of the manhole both the stresses and the deformation are greatest.

The experiments show that the stresses around manholes far exceed those imagined by designers, so that in many cases the material is locally stressed up to the flow point when the drums are subjected to ordinary working pressures. This indicates the extreme importance of further study along this line and of new standards for the design of dished heads, particularly heads containing manholes. The bad effect of manholes is exaggerated when they are placed off-center or when they are of elliptical rather than of circular section.

[1] An abstract of these papers appeared on page 72 of the Jan. 11 issue of *Power*.

News in the Field of Power

New Bailey Meter Co. Acquires G. E. Flow Meter Business

A new company, to be known as the Bailey Meter Co., is being formed, and on April 1 will acquire the flow meter business and patents of the General Electric Co., and the fluid meter and combustion control business and patents of the present Bailey Meter Co. Payment for the flow meter business and patents will be made to the General Electric Co. in the stock of the new company, of which the other principal holder will be the Babcock & Wilcox Company.

The engineering, manufacturing and sales organizations of the present Bailey Meter Co. will be retained by the new company, with the increase in personnel necessary from the General Electric Co. to handle properly the additional business. The new company will have its factory and general offices in Cleveland, Ohio.

Complete Flow Meter Line

E. G. Bailey, president of the present Bailey Meter Co., will be president of the new company. R. S. Coffin, vice-president of the present Bailey Meter Co., will be vice-president in charge of administration and finances. R. E. Wooley, now connected with the General Electric Co., will be vice-president in charge of engineering and sales.

The new Bailey Meter Co. will offer its customers a complete line of flow meters, boiler room instruments and combustion control equipment.

Fuller-Lehigh Take Over Bailey Furnace Appliances

Simultaneously with this announcement come advices from the Fuller Lehigh Co., that on April 1 it will take over that portion of the business of the Bailey Meter Co. pertaining to pulverized coal feeders, burners, and water cooled furnace walls.

Grouping this equipment with the pulverizing mills, driers, conveying systems, feeders and burners, now gives the Fuller-Lehigh Co. complete equipment, not only of pulverized coal apparatus from the preparation plant to the furnaces, but for the construction of the furnace as well.

Same Working Schedule

The Bailey water cooled furnace wall which has been satisfactorily applied to various types of furnaces will still be available for stoker, gas, and oil as well as pulverized coal fired boilers.

The Fuller Lehigh Co. will complete the contracts for furnace walls, and other similar equipment now on order with the Bailey-Meter Co., and all this work will be carried on the same schedule and with substantially the same personnel as in the past.

The sales organization includes E. J. Billings, vice-president in charge of sales, H. G. Barnhurst, H. R. Collins, A. P. Hachtmann, W. C. Renkin, and D. H. Mayo, formerly with the Ford Motor Co.

A.S.T.M. Slate Western Meet —International Congress Up

Program details are now being developed for the thirtieth annual meeting of the American Society for Testing Materials, and the twenty-fifth anniversary of the incorporation of that society, which will be held at French Lick Springs Hotel, French Lick, Ind., June 20 to 24, inclusive. In order to include the many features on the slate a number of simultaneous sessions are scheduled. The first day, Monday, will be devoted to committee meetings, and the first general session will take place in the morning or afternoon of Tuesday, June 21.

Reports and papers called for by the program include, so far as metals are concerned, studies on fatigue testing and on the testing of thin sheet metals.

Dudley Medal Award

The 1926 crop of papers presented at that annual meeting has been reviewed by the special committee appointed by the executive committee; according to its decision, the first award of the Charles B. Dudley Medal will go to the author of the paper of most outstanding merit as an original contribution on research in engineering materials.

The Edgar Marburg Lecture will again be a feature of the program, and a special session will probably be devoted to it.

In addition to the annual golf and tennis tournaments, a committee is outlining a number of entertainments for the ladies attending the meeting. This year the passenger associations have granted reduced rates for attending members. Round trip tickets will be sold at the rate of one and one-half single fare to holders of identification certificates secured through the society. Application for these should be made as soon as possible.

International Congress Planned

Acting upon an agreement reached at an international conference on materials held last September in Zurich, the Dutch and Swiss Associations for Testing Materials have issued invitations to an International Congress for Testing Materials to be held at Amsterdam, Holland, Sept. 12-17. This gathering will resume the international co-operation in the domain of testing materials that was interrupted in 1914. The executive committee of the American society has accepted this invitation to participate, and it is planned to have one or more official delegates attend and a presentation made of topical reports and papers.

T. D. Lynch, manager, Materials and Process Engineering Department, Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa., is chairman of a special committee in charge of the plans for participation.

Scores Congress' Trifling With Tennessee Project

Any effort to make the water powers of Tennessee the football of politics, along with Muscle Shoals, is condemned by Senator Tyson in a formal statement issued in Washington March 20. He says in part:

"In view of the situation and the question that has arisen as to what the rights of the state are, and as to whether the Federal Water Power Act is constitutional, it seems to me the Legislature should take some action at this session defining the position the state desires to take in the matter, as it will be two years before the Legislature meets again. If we are not careful, the development of the water powers of the Tennessee and Clinch Rivers is going to be greatly delayed, and it may be five to seven years before any power can be secured from the Clinch and the Tennessee.

"If the Clinch River development is to be delayed until Muscle Shoals is disposed of, and if everything is dependent upon what is done with Cove Creek, it is easy to be seen that it may be two or three years before any permit will be granted to anyone on the Clinch and Tennessee Rivers, and it will be from three to five years before power is available after a permit is granted to anyone.

"I think that Congress has the right to do as it deems best with Muscle Shoals, but it does seem that the water powers of Tennessee should not have to be made the football of politics by the Congress of the United States simply because the Congress will no nothing with Muscle Shoals."

Faulty Safety Valve Causes Ammonia Explosion

Failure of the functioning of a safety valve on the compressor of a Frigidaire type refrigerating system caused the explosion of an ammonia tank at an ice cream establishment at 117 Main Street, Flushing, N. Y., late in the afternoon of Feb. 27.

The head of the compressor blew off when the relief valve failed, according to findings of the investigation instituted by the Fire Prevention Bureau of Brooklyn some days after the accident. The capacity of the system was less than three tons. It was installed by the General Motors Corp.

America To Share in Volta Centenary—Plans Fellowship

Thomas A Edison will be honorary chairman and Maurice A. Oudin, vice-president of the International General Electric Co., chairman of a committee formed by Italian-American and electrical interests to represent America at exercises commemorative of the death of Alessandro Volta on March 5, 1827. The exercises will be held at Como, Italy, Volta's native city, in June, when exhibits from all over the world will be shown there.

"Representing interests which owe a debt to Volta, we think it appropriate that Americans should create some memorial to him," the committee in charge said in a formal statement. "It is proposed that this memorial should take the form of an annual fellowship to an Italian electrical engineer, enabling him to spend one year in the United States in study and research. It is hoped that the announcement of the establishment of the fellowship may be made at the June meeting in Como."

Reichsmuseum Houses Permanent Industrial Exhibits

The motives of the foundation of the Reichsmuseum, which was recently opened at Düsseldorf, Germany, were based on a policy to foster an improvement in industrial exhibits, to preserve the most outstanding exhibits shown at the various annual industrial conventions or fairs, and to picture for the general public the progress made in economics from the time of primitive man to the present day.

Maps and physical and commercial geographical exhibits indicate where the raw materials are obtained, and show, in order, their consumption by all industries, those factors which influence the domestic and world markets for the finished products, and, lastly, the importance of cordial international relations in the furthering of commercial success.

A special branch of the museum is devoted to sociological studies and to exhibits in the advance of hygienic science. In their arrangement the displays are so shown as to preserve a flexibility which permits the museum to keep pace with the latest inventions.

It is the ideal of those heading the foundation that the gradual education of the public will lead to a better understanding of existing economic conditions and eventually to a greater elimination of preventable waste of natural resources.

Reichsmuseum at Düseldorf, Germany, Planned as Institute for Permanent Industrial and Social Exhibits

Towne Scientific School Has Fuel Engineering Course

A comprehensive, practical one-year course in fuel engineering, conducted by leading national authorities, will be opened at the Towne Scientific School of the University of Pennsylvania, Sept. 30.

Leading to the degree of Master of Science in Fuel Engineering, the course is planned to embrace the study of fuel resources; mining methods, preparation for market, distribution and storage and re-handling; composition and combustion of fuels; manufacture of special fuels; uses of fuels and specifications for purchase; furnaces; fuel sampling, analysis and calorimetry; fuel testing in heating and power appliances; domestic heating, cooking and smoke elimination; regulations affecting use of water power and of fuel resources, and research.

Intended primarily for those who have had the advantage of an undergraduate education and who have also had practical experience in fields allied to fuel engineering, the course will be open to a limited number of applicants who are not holders of college degrees, but who are qualified to pursue work in special divisions of the general course. Application for enrollment should be made to Dean John Frazer, Towne Scientific School, University of Pennsylvania, Philadelphia, Pa.

Assisting H. Fernald, head of the department of mechanical engineering, who will be the director of the course, fifty prominent engineers will serve as an instructional staff and as lecturers. Among their number are E. G. Bailey, Fuller Lehigh Co., E. H. Bauer, Worcester Gas Light Co., J. S. Bennett, American Engineering Co., A. C. Fieldner, chief chemist, U. S. Bureau of Mines, Pittsburgh, Pa., C. M. Haupt, chief engineer, Standard Oil Company of New Jersey, Henry Kreisinger, Combustion Utilities Corp., New York, G. A. Orrok, consulting engineer, New York City, F. E. Pendleton, New York Steam Corp., H. C. Porter, consulting engineer, Philadelphia, Pa., and J. H. Walker, Detroit Edison Co.

Electrochemists To Hold Silver Jubilee

The American Electrochemical Society will celebrate its silver jubilee at the coming national spring meeting to be held at the Hotel Benjamin Franklin, Philadelphia, Pa., April 27 to 30, inclusive.

Many of the charter members will attend the Philadelphia convention, and a number of them will present brief accounts of the early days of the Society and the development of their particular electrochemical line during these past twenty-five years. C. G. Schluederberg, of the Westinghouse Electric & Manufacturing Co., is chairman of arrangements, and Dr. Edgar Fahi Smith, of the University of Pennsylvania, an honorary member of the Society, will preside.

The changes that have taken place in electrochemistry, in both theory and practice, will be strikingly portrayed in two of the other main sessions of the convention. One of these will be devoted to a symposium on the electrochemistry of concentrated solutions. An outstanding feature of this symposium will be the address by Dr. Peter Debye, of the University of Zurich, on "The Dielectric Constant of Electrolyte Solutions." Professor Debye has been one of the foremost exponents of the new theoretical developments in electrochemistry and he will participate actively in all of the discussion. Dr. Hugh S. Taylor, of the University of Princeton, will preside at this session, and papers will be presented by Dr. George Scatchard, of Massachusetts Institute of Technology, Dr. T. J. Webb, of Princeton, Dr. Herbert S. Harned, of the University of Pennsylvania, and Dr. Victor K. LaMer, of Columbia. The subject of concentrated solutions is not only of interest to the theoretically inclined electrochemists, but is of even greater interest to many of the industrial electrochemists.

The Electrothermic Division of the Society has arranged a very interesting session on the gaseous reduction of ores and other metal compounds. The Electrodeposition Division will hold a session on Saturday morning to discuss a series of papers on chromium, cobalt, nickel, zinc, copper and tin.

Many interesting visits have been arranged to various industrial plants in and near Philadelphia. The convention promises to be the largest and most attractive in the annals of the Society.

General Bituminous Strike Believed Unlikely

That there will be no general strike of union bituminous miners on April 1, is a growing impression given further impetus by the signature of temporary agreements, in the outlying fields, extending the Jacksonville scale until such time that the central competitive wage can be fixed.

Hopkins Engineering Courses Remain Under New Plan

For the present the School of Engineering of the Johns Hopkins University will continue as formerly to offer its regular four-year undergraduate courses and graduate instruction, according to an authorized statement issued by Dr. Frank J. Goodnow, president of the university.

Only such changes in curricula will be made under the new plan for university work as are found necessary to conform with the modified courses in the College of Arts and Sciences.

Ship Installs Pulverized Coal System

The first pulverized coal installation in the world aboard a ship is now being installed in New Orleans by the Inland Waterways Corp. on the steamer "Illinois." If successful, this installation will revolutionize equipment aboard ships throughout the world.

If pulverized coal can be successfully burned in the small furnace volumes available on ships, then vessels going to sea can be equipped with high-pressure boilers, high-pressure engines and electric auxiliaries and made to compete with the Diesel-engined ship being built today. This offers the only solution to the steam equipment manufacturers.

But, the problem to be overcome is the burning of coal in extremely small furnace volumes. In a marine installation as much as ten pounds of coal has to be successfully burned per cubic foot of furnace volume. In addition, any kind of coal, obtainable in all parts of the world, has to be used.

Credit for making this test installation aboard the steamer "Illinois" goes to Gen. T. Q. Ashburn, chairman and executive, and A. R. Wurtele, chief engineer, both of the Inland Waterways Corporation.

To Witness Trial Runs

These tests will be watched with interest by the marine and engineering world. The United States Navy, through its chief engineer, Admiral John J. Halligan, Jr., is sending Commander Evans and Lieut.-Comdr. Malloy; while the Fuel Conservation Committee of the United States Shipping Board, through Captain McAllister, head of the American Bureau of Shipping, is sending C. J. Jefferson, head of the technical section of the committee, to be present during the trial runs of the "Illinois." Capt. A. O. Ackard, marine superintendent, of the Carnegie Steel Co., Pittsburgh, Pa., will also be present as will representatives from different engineering societies and manufacturers.

The "Illinois" is fitted with two United States Shipping Board Standard, Conti Type boilers, each having 4,200 sq.ft. of heating surface, equipped with economizers and superheater tubes in the uptakes, operating on 250 lb. steam pressure, 30 deg. F. superheat.

Two different type unit pulverizers will be installed, one a high-speed machine and the other a ball tube mill. As representative of the high-speed machines, the Aero unit type pulverizer has been selected and will be connected to one boiler. As representative of the low-speed ball mill, the Kennedy air swept tube mill has been selected and this will be connected to the other boiler of the "Illinois."

The boiler equipped with the Aero mill will be fitted with tile for preheated air.

The boiler equipped with the Kennedy mill will be fitted with air-cooled side and rear walls and floor.

Dieselization of American Ships Under Way

The first results of the Dieselization program of the United States Shipping Board are being witnessed in the success of six vessels now in service as motorships. All these vessels, which are steel cargo-carriers, have been converted from steam propulsion to propulsion by internal-combustion engines known as Diesel engines.

Experiments with this type of engine have been conducted in various parts of the world for the last fifteen years, but it is only since the close of the war that they have been given extensive use on big ocean-going vessels. At the present time these engines are at a comparatively high state of perfection and their adoption as a means of propulsion by many foreign shipping lines has greatly advanced the standards of cargo ships. In some cases, also, Diesel propulsion is being used for passenger ships. Vessels of this character are being designed to go at 20 or 22 knots an hour.

American participation in Diesel-engine and motorship construction has been limited by the same forces which have limited the construction in American yards of ocean-going vessels of all types. To build ships in the United States for operation in foreign trade costs from 25 to 30 per cent more than such construction does abroad, because of higher material and labor costs. The same higher costs affect the cost of operation under the American flag, and, in addition, the cost of insurance is greater in the United States. What has been accomplished, therefore, has been through the Dieselization program of the government. Under it the Shipping Board is authorized by Congress to spend amounts totaling not more than $25,000,000 on the conversion of steamers built during war time to motorships.

Rising Tendency Apparent in Manufacturing Activities

Wage levels and plant activity in the manufacturing industries of the United States, in contrast to the feeling of uncertainty that prevailed in many quarters at the beginning of the year, showed a firm and perceptibly rising tendency during January, according to the National Industrial Conference Board, 247 Park Ave., New York. Evidence of the soundness of underlying conditions is seen by the Conference Board in the unprecedented stability of wage and employment trends during the entire past two years, in the very gradual increase in the purchasing value of the dollar as measured by living costs, and in the increasing industrial activity during a period which on the whole has been one of declining commodity prices.

Employment at Even Level

Changes in wage earnings and employment from December of last year to January as computed by the Board for more than 2,000 manufacturing establishments in 25 industries were slight, but afford no basis for pessimistic forecasts. Average weekly earnings per worker showed a slight increase, indicating increased plant activity, while average hourly earnings, quickly reflecting changes in wage rates, remained stable at 56.5 cents. Employment remained practically unchanged at 81 per cent of the peak figures of June, 1920, and was still above the level of January the preceding year. Average hours of work per wage earner, the most sensitive index of plant activity, increased from 47.9 in December to 48.2 in January.

Workers' Earnings Stable

The extraordinary stability of employment conditions is manifested in the Board's monthly records of wage earnings for the last two years, average hourly earnings having changed less than 3 per cent and average weekly earnings less than 5 per cent since January, 1925. Both average hourly and weekly earnings per worker at the beginning of this year stood at almost exactly the same level as in January of both preceding years. "Real weekly earnings"—that is, the purchasing power of the factory worker's weekly pay at the beginning of 1927—were 30 per cent greater than they had been in July, 1914.

Personal Mention

Alfred H. Exton is now chief engineer of the American Manganese Steel Co., Chicago Heights, Ill.

A. G. Pratt, president of the Babcock & Wilcox Co., sailed from New York City for Europe, March 12.

Dale F. Reese, mechanical engineer, is now connected with the Hartford Steam Boiler Inspection and Insurance Co., Hartford, Conn.

Otto Nonebruch has become assistant chief engineer for the Worthington Pump & Manufacturing Corp. at the Buffalo, N. Y., works.

Claude J. Burrage has severed his connection with the Chapman Valve Co., as electrical and mechanical engineer, and has opened a sales engineering office in Philadelphia, Pa.

D. B. Tuxhorn is now doing power-plant engineering work under the title of assistant mechanical inspector on the operating vice-president's staff of the Chicago, Burlington & Quincy Railroad.

G. B. Newby, Jr., has changed his position from plant engineer at the Pacific Sheet Steel Corp., South San Francisco, Calif., to estimator for J. T. Thorpe & Son, furnace designers, San Francisco.

Loughman Pendred, editor of *The Engineer* (London), will arrive in the United States about the middle of April.

F. C. Evans, professor of heat power engineering at the Sibley School of Mechanical Engineering, Cornell University, is on leave of absence to work in the engineering department of the Krebs Pigment & Chemical Co., Wilmington, Del.

Society Affairs

The Metropolitan Section of the A.S.M.E., at 29 West 39th St., New York City, at 8, April 4, will be addressed by B. P. Coulson, Jr., engineer with the General Electric Co., on "The Generation of Electricity by Mercury Vapor Process."

The Detroit Section of the A.S.M.E. meeting at the Detroit Engineering Society Clubhouse the evening of March 30, will hear an address by Charles S. Gladden, director of power and construction for the General Motors Corp., on "Industrial Power Plants."

The Ontario Section of the A.S.M.E. will meet in the Mining Building of the University of Toronto at 8 p.m., April 19 for a lecture on the application of Diesel oil engines, by George R. Wyer, manager of the engine department, Canadian Fairbanks Morse Co., Toronto.

Business Notes

The Dearborn Chemical Co. announces the change of address of its Boston office, which will be located in Room 908, Charles Chauncy Bldg., 38 Chauncy Street, after April 1.

The Chicago Fuse Manufacturing Co. of Chicago, Ill., has purchased the Powerlet line of rigid conduit fittings formerly manufactured by the Multi-Electrical Manufacturing Co. Henceforth the Powerlet line will be known as Gem Powerlet conduit fittings.

The American Hammered Piston Ring Co., of Baltimore, Md., has enlarged its sales organization, having secured the services of H. W. Marshall, formerly with the Anderson Co., Gary, Ind. His territory will include Kansas, Arkansas, Oklahoma, and part of Missouri.

The L. J. Wing Manufacturing Co., New York, has recently appointed C. W. Diemecke as Chicago representative. Mr. Diemecke, with headquarters at 549 West Randolph Street, will handle the Wing line of unit heaters, forced draft blowers, fans, exhausters, small turbines, etc.

The Wm. B. Scaife & Sons Co. has announced the one hundred and twenty-fifth anniversary of the establishment of its business. J. V. Scaife is president and A. M. Scaife, vice-president. Offices are located at Pittsburgh and Oakmont, Pa., New York City and Chicago.

Coming Conventions

American Association of Engineers. Annual convention, Tulsa, Okla., June 6-8; M. E. McIver, 63 East Adams St., Chicago.

American Boiler Manufacturers Association. Annual meeting at French Lick Springs Hotel, French Lick, Ind., May 30-June 1.

American Eletrochemical Society. Silver jubilee meeting at Philadelphia, Pa., April 27-30; H. E. Dalling, sec., Columbia University, New York.

American Institute of Electrical Engineers. F. L. Hutchinson, secretary, 33 West 39th St., New York City. Bethlehem, Pa. regional meeting April 21-23, Pittsfield, Mass. regional meeting May 25-27. Summer convention at Detroit, Mich., June 20-24 inclusive; Pacific Coast convention at Del Monte, Calif., Sept. 13-16.

American Oil Burner Association. Annual convention and exposition at Buffalo, N. Y., April 5-7.

American Order of Steam Engineers. Annual convention, Moose Hall, 1314 North Broad St., Philadelphia, Pa. June 13-16; J. E. Burke, 1821 So. Ringgold St., Philadelphia.

American Refractories Institute. Spring meeting at Hotel Traymore, Atlantic City, N. J., May 18-19; D. A. Texter, secretary, 2202 Oliver Bldg., Pittsburgh, Pa.

American Society of Civil Engineers. George T. Seabury, secretary; Spring convention at Asheville, N. C., April 20-22. Annual convention at Denver, Col. July 13-15.

American Society of Mechanical Engineers. Spring meeting at White Sulphur Springs, W. Va., May 23-26. Calvin W. Rice, secretary. Midwest regional meeting will be held in Kansas City, April 4-6 inclusive; F. S. Dewey, chairman

American Society of Refrigerating Engineers. of the Kansas City Section. Western meeting at White Sulphur Springs, W. Va., May 23-25, in conjunction with the Spring meeting of the A.S.M.E.; W. H. Ross, 35 Warren St., N. Y.

American Society for Testing Materials. Annual convention at French Lick Springs Hotel, French Lick, Ind., June 20-24; J. K. Rittenhouse, secretary, 1315 Spruce St., Philadelphia, Pa.

American Water Works Association. W. M. Niesley, assistant secretary, 170 Broadway, N. Y. Annual convention Hotel Sherman, Chicago, June 6-11.

American Welding Society. Annual meeting at 29 West 39th St., New York City, April 27-28-29.

Association of Iron and Steel Electrical Engineers. Annual convention at Pittsburgh, Pa., June 13-18, inclusive.

National Association of Practical Refrigerating Engineers. Annual convention probably in November; E. H. Fox, 5707 W. Lake St., Chicago, Ill.

National Association of Stationary Engineers—Annual convention at Ambassador Hotel, Los Angeles, Calif., Aug. 22-27; John Topman, secretary, convention committee, Ohio State annual convention in Memorial Hall, Lima, Ohio, June 16-18; P. H. Grigsby, secretary, Lima, Ohio. New England States convention at Portland, Me., June 17-18; Thomas H. Clark, president, Worcester, Mass.; Robert Johnson, secretary, 65 Charlotte St., Worcester, Mass. Indiana State convention at Anderson, May 27-28.

National Board of Boiler and Pressure Vessel Inspectors. Annual meeting at Nashville, Tenn., June 8.

National Electric Light Association. A. Jackson Marshall, secretary, 29 West 39th St., New York City. Convention at Atlantic City, June 6.

Universal Craftsmen Council of Engineers. Thomas H. Jones, secretary, 33 Linden Ave., Cherrydale, Va. Annual convention at Buffalo, N. Y. Aug. 2-6.

The General Electric Co. has recently opened a service shop and warehouse in Buffalo, N. Y.

The Hunter Machinery Co., of Milwaukee, Wis., has been appointed dealer in Climax engines and power units, by the Climax Engineering Co., Clinton, Iowa. The new dealer will also maintain a supply of parts for Climax engines.

Engineering Co., Clinton, Iowa, has made agreements with the Belknap Hardware & Manufacturing Co. Louisville, Ky., by which this organization will handle the sales of Climax engines in Kentucky, northern Tennessee, West Virginia and portions of Virginia and

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run except Pittsburgh gas slack:

Bituminous Net Tons	Market Quoting	Mar. 21 1927
Pool 1	New York	$2.75@$3.25
Smokeless	Boston	1.88
Clearfield	Boston	1.65@ 2.00
Somerset	Boston	1.75@ 2.10
Kanawha	Columbus	1.40@ 1.75
Hocking	Columbus	1.65@ 1.90
Pittsburgh	Pittsburgh	1.80@ 1.90
Pittsburgh gas slack	Pittsburgh	1.60@ 1.70
Franklin, Ill	Chicago	2.50@ 2.75
Central, Ill.	Chicago	2.00@ 2.25
Ind. 4th Vein	Chicago	2.40@ 2.50
West Ky.	Louisville	1.40@ 1.75
S. E. Ky.	Louisville	1.40@ 1.65
Big Seam	Birmingham	1.50@ 2.00
Anthracite Gross Tons		
Buckwheat No. 1.	New York	2.50@ 3.00
Buckwheat No. 1.	Philadelphia	2.50@ 3.50
Birdseye	New York	2.00

FUEL OIL

New York—March 24, light oil, tank-car lots; 28@34 deg. Baumé, 5¾c. per gal.; 36@40 deg., 6c. per gal. f.o.b. Bayonne, N. J.

St. Louis—March 15, tank-car lots, f.o.b. St. Louis; 24@26 deg., $2 per bbl.; 26@28 deg., $2.05 per bbl.; 28@30 deg., $2.10 per bbl.; 30@32 deg., $2.15 per bbl.; 32@36 deg., gas oil, 5.8c. per gal.; 38@40 deg., 6.25c. per gal.

Pittsburgh—March 15, f.o.b. local refinery; 30@34 deg., fuel oil, 6¼c. per gal.; 36@40 deg., fuel oil, 6.5c. per gal.

Philadelphia—March 23, 27@30 deg., $2.52@$2.58 per bbl.; 13@19 deg., $2@$2.06 per bbl.

Cincinnati—March 21, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 6½c. per gal.; 26@30 deg., 6⅝c. per gal.; 30@32 deg., 7c. per gal.

Chicago—March 19, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 92c. per bbl.; 24@26 deg., $1.25 per bbl.; 26@30 deg., $1.30; 30@32 deg., $1.60.

Boston—March 21, tank-car lots, f.o.b. 12@14 deg. Baumé, 4.85c. per gal.; 28@32 deg., 6c. per gal.

Dallas—March 19, f.o.b. local refinery, 26@30 deg., $1.75 per bbl.

North Carolina; and Woodward-Wight & Co., New Orleans, La., dealers in Climax engines for southern Louisiana and southern Mississippi.

The Electric Controller & Manufacturing Co. of Cleveland announces the EC&M Type WB brake, a new development to meet the demand for a shoe-brake giving longer life of brake shoe linings and permitting quick removal of the motor armature with brake wheel in place, without the necessity of taking the brake apart or disturbing any of its adjustments. It is an exceptionally fast operating brake, according to report.

Trade Catalogs

Storage Water Heaters—The Gradon Manufacturing Co., Land Title Building, Philadelphia, Pa. Storage water heaters of the U type manufactured by the company are dealt with in Bulletin No. 31.

Wrought Construction Expansion Joints—The Gradon Manufacturing Co., Land Title Building, Philadelphia, Pa., has issued Bulletin No. 11 devoted to wrought construction expansion joints of the sliding sleeve type, ¾ in. to 72 in. Descriptions and price lists are included in detail.

Steam Separators—The Gradon Manufacturing Co., Land Title Building, Philadelphia, Pa., in Bulletin No. 21 treats of the plain and receiver types of steam separators. Dimensions and price lists are given.

Recuperators — The Carborundum Co., Perth Amboy, N. J., in Bulletin No. E-11 describes the silicon carbide refractories sold under the trade name of "Carbofrax." Three figures showing sectional views are given.

Ice Water Treatment and Purification, Manufacture of Ice—The Middle West Utilities Co., Chicago, has published a book called "Ice," which is essentially a handbook of the history and growth of the ice industry, prepared under the direction of A. J. Authenrieth, vice-president in charge of ice engineering.

Anti-friction Metal, Lined Bearings—The Magnolia Metal Co. has just published for free distribution a new and revised edition of the Magnolia bearing metal handbook. This handbook comprises 96 pages of practical data, suggestions and instructions on the selection and preparation of bearing metals for various kinds of service. The book is illustrated with several sketches showing approved methods of arranging the shells for babbitting, proper proportions and clearances of bearings, and various arrangements of oil grooves with which good results have been obtained in service. Copies of the handbook may be obtained free by addressing the Magnolia Metal Co., 75 West St., New York City.

Automatic Arc Welding—The General Electric Co. A new booklet, GEA 586, shows several forms of automatic arc welding machines designed to form the longitudinal and circular seams of cylindrical tanks. Arc welders arranged for such special jobs as the building up of locomotive guide rods, worn wheel flanges, etc., are also described. The pamphlet contains a table giving the speed with which a butt weld can be produced on various thicknesses of steel plate.

De Laval Pumps—Under the title "De Laval Pumps at Greensboro, N. C." the De Laval Steam Turbine Co. has described a pumping system in which an original capacity of 4,500,000 gallons daily was increased to an ultimate 22,000,000 gallons daily without expenditure for new buildings, and with a marked improvement in fuel economy, by the substitution of steam turbine driven centrifugal pumps for Corliss and Meyer valve gear, crank and fly wheel units. This leaflet will be of interest to waterworks engineers who are faced with the necessity of increasing the capacity of old pumping stations.

New Plant Construction

Calif., Fresno—A. Pantages, 913 Pantages Theatre Bldg., Los Angeles, is having plans prepared for the construction of a theatre and office building including steam heating, refrigeration and ventilation systems, etc. at Tuolumne and Fulton Sts. Estimated cost $600,000. B. M. Priteca & B. Sonnickson, 913 Pantages Theatre Bldg., Los Angeles, are architects. E. B. Newcomb, 907 Pantages Theatre Bldg., Los Angeles is supervising engineer.

Calif., Los Angeles — Blackstone Hotel Co., c/o K. MacDonald, Jr., Spring-Arcade Bldg., Archt., is having preliminary plans prepared for the construction of a 12 story hotel at 9th St. and Broadway.

Calif., Los Angeles—Merchants National Bank Bldg., awarded contract for the construction of a 12 story bank and office building on Spring St. to P. J. Walker Co., W. M. Garland Bldg. Estimated cost $1,000,000.

Calif., Los Angeles—P. M. Ruthfield Investment Co., 919 South Valencia St., awarded contract for the construction of an 8 story apartment at 712-716 West Ninth St., to Salih Bros., 1114 Quinby Bldg. Estimated cost $500,000. Steam heating system, elevators, etc., will be installed.

Calif., Visalia—Knudsen Laboratories, 1965 Santee St., Los Angeles, is having plans prepared for the construction of a creamery plant, power house, etc. Estimated cost $60,000. Train & Cressey, Western Mutual Bldg., Los Angeles, are architects.

Conn., New Haven—United Illuminating Co., 84 Temple St., plans the construction of addition to power plant including one 7,500 kw. generator and two 12,500 kw. turbine generators. Estimated cost $3,000,000.

Ill., Chicago—Johnston Bros., 77 West Washington St., awarded contract for masonry, etc., for a 9 story apartment at 6927 Crandon Ave. Estimated cost $1,000,000. Six elevators will be installed.

Ill., Chicago—Olympia Beach Club, 310 South Michigan Ave., is having sketches made for the construction of an 8 or 10 story hotel and club building on Chase Ave. Estimated cost $1,000,000. Huszagh & Hill, 6 North Michigan Ave., are architects.

Ill., Chicago — Six Thousand Grandon Ave. Building Corp., c/o Quinn & Christensen, 360 North Michigan Ave., Archts., is having sketches made for the construction of a 13 story apartment at 67th St. and Grandon Ave. Estimated cost $900,000.

Ill., Chicago—Syndicate, c/o C. Weinfeld, 232 South Clark St., is having plans prepared for the construction of a 20 story apartment at Sheridan Rd. and Melrose Ave. Estimated cost $2,000,000. McNally & Quinn, 8 South La Salle St., are architects.

Ill., Rockford—George D. Roper Corp., South Main St., awarded contract for the construction of a plant and power house to Frank R. Chase, Inc., 720 North Michigan Ave., Chicago. Estimated cost $250,000.

Ind., Indianapolis—Indian Refining Co., 3516 East New York St., will build a boiler room, etc. Estimated cost $72,000. Private plans.

Kan., Emporia—Sisters of St. Francis, plans the construction of a hospital and boiler room. Estimated cost $300,000. Brickman & Hagan, 513 Citizens National Bank Bldg., are architects.

Ky., Louisville — Nevin Wischemeyer & Morgan, Starks Bldg., will soon award contract for the construction of a hospital including refrigeration and ventilation systems, separate boiler house, two boilers, etc., at Shelby St. and East Parkway. Estimated cost $500,000.

Md., Hagerstown—City awarded contract for the construction of a lighting plant to Bester-Long Co. Estimated cost $171,500.

Mass., Arlington (Boston P. O.)—Arlington Gas Light Co., 689 Massachusetts Ave., is receiving bids for the construction of a compressor room and boiler house on Grove St. Estimated cost $40,000. Private plans.

Mass., Canton—Edison Electric Illuminating Co., 39 Boylston St., Boston, is receiving bids for the construction of a power plant on Revere St. here. Estimated cost $40,000. Private plans.

Mass., Haverhill—Haverhill Electric Co., 121 Merrimack St., is receiving bids for the construction of addition to switch house. Estimated cost $40,000. C. H. Tenney & Co., 200 Devonshire St., Boston, are engineers.

Mass., Malden (Boston P. O.)—Syndicate, c/o J. S. Draper, 209 Washington St., Boston, is having preliminary plans prepared for the construction of an 8 story hotel on Pleasant St., here. Estimated cost $3,000,000. R. H. Doane, 162 Newbury St., Boston, is architect.

Mass., Quincy (Boston P. O.)—V. Kaufman, 18 Tremont St., Boston, plans the construction of hotel here. Estimated cost $2,000,000. Architect not selected.

Mich., Detroit—J. B. Book, Jr. Corp., Book Bldg., will receive bids about Apr. 8 for the construction of a 16 story apartment including steam heating and refrigeration systems, boilers, elevators, etc. on Jefferson Ave. Estimated cost $5,000,000. L. Kamper, Kamper Bldg., Cass Ave., is architect.

Mich., Midland — Detroit Creamery Co., Cass and Grand River Aves., will receive bids until Apr. 7 for the construction of a condensery and power plant including refrigeration system, boilers, pumps, etc. A. Kahn, 1000 Marquette Bldg., Detroit, is architect.

Mich., Muskegon Heights — Consumers Power Co., W. M. Lewis, Dist. Mgr., will build an electric power utility service building on Peck St. by day labor. Estimated cost $60,000. Private plans.

Minn. Minneapolis — Wesley Methodist Church, J. W. Sprague, Pres. of Corp., First Ave. and South Grand St., awarded contract for the construction of 10 story church and hotel building to Wells Bros. Construction Co. 53 West Jackson Blvd.,

Chicago, Ill. Estimated cost $5,500,000. Steam heating system, elevators, etc. will be installed.

Miss., Vicksburg—Syndicate, c/o Weiss, Dreyfous & Seiferth, Maison Blanche Bldg., New Orleans, La., Archts., is having preliminary plans prepared for the construction of a 10 story hotel including steam heating system, three electric elevators, etc. here. Estimated cost $1,000,000.

Mo., St. Louis—R. M. Tucker, c/o Missouri Pacific R.R., Railway Exchange Bldg. and Mauren, Russel & Crowell, Chemical Bldg., Assoc. Archts., will receive bids until Apr. 10 for the construction of a 22 story office building at 13th, Pine and Olive Sts. for Missouri Pacific R.R. Estimated cost $2,000,000. E. A. Hadley, is chief engineer.

Neb., Fremont—City, J. Rextlenry, Chn. of Bldg. Committee, will soon award contract for the construction of addition to power plant. Burns & McDonnell, Interstate Bldg., Kansas City, Mo., are engineers.

Nev., Fallon—Truckee-Carson Irrigation Dist., is having plans prepared for the construction of a pumping plant 60 sec. ft., 100 ft. lift. D. S. Stuver, is engineer.

N. J., Hamburg — Borough Council will receive bids until Mar. 30 for the construction of a waterworks and distribution system including well, pumping station, etc. J. A. Foulks, 20 Beaver St., Newark, is consulting engineer.

N. Y., Glens Falls—Union Bag & Paper Co., 233 Broadway, New York, plans the construction of a hydro-electric generating station, 50,000 hp. capacity, here. Estimated cost $2,000,000. Private plans.

N. Y., New York—Madison Ave. and Sixthieth St. Corp., L. W. Klein, 501 5th Ave., awarded contract for the construction of a bank and office building at 21 East 60th St. to Shroder & Koppel Inc., 347 Madison Ave. Estimated cost $1,000,000.

O., Cleveland—Canfield Oil Co., M. C. Dippel, Purch. Agt., 3216 East 55th St., awarded contract for the construction of addition to boiler house on East 52nd St. to A. H. Binns Co., 7504 Carnegie Ave. Estimated cost $40,000.

Okla., Canton—City voted $20,000 bonds for extensions and improvements to electric light plant including 200 hp. Diesel engine and generator. Estimated cost $20,000. H. H. Dohe, Okeene, is engineer.

Okla., Enid—Banfield Bros. Packing Co., is having preliminary plans prepared for the construction of a packing plant and boiler room, etc. Estimated cost $50,000. L. J. Menges, 405 Franklin Ave., St. Louis, Mo., is architect. G. Birkland, 405 Franklin Ave., St. Louis, Mo., is engineer.

Okla., Lawton—Southwestern Light & Power Co., Braniff Bldg., Oklahoma City, awarded contract for the construction of a 65 ton ice plant at 3rd and B Aves. here. to Campbell & Price, 605½ Main St., Oklahoma City, Estimated cost $175,000. Machinery will be installed.

Pa., Philadelphia—C. E. Oelschlager, 1615 Walnut St., Archt., is making preliminary sketches for the construction of a 20 story hotel at Carlisle and Pine Sts. Estimated cost $1,000,000. Owners name withheld.

Pa., Philadelphia—One Thousand Nine Locust St., Corp., c/o W. J. Taube, 19th and Chestnut Sts., is having plans prepared for the construction of a 25 story hotel. Estimated cost $3,000,000. F. E. Hahn, 629 Chestnut St., is architect.

Pa., Philadelphia—Whitshire Realty Co., c/o J. Merkel & Co., Weidener Bldg., awarded contract for the construction of a 22 story bank and o'ce building at 15th and Walnut Sts. to Thompson-Starrett Co., Packard Bldg. Estimated cost $1,750,000.

Pa., Pittsburgh—Mutual Building Co., T. R. Hinckley, Benedum Trees Bldg., Archt., awarded contract for the construction of a 10 story apartment to W. T. Grange Construction Co., Keenan Bldg. Estimated cost $1,500,000.

Pa., Pittsburgh—Webster Hall Corp., awarded contract for the construction of a 10 story addition to hotel on 5th Ave. to P. A. Miller & Co., 600 Majestic Bldg., Detroit, Mich. Estimated cost $1,500,000.

Pa., Swissvale—Union Switch & Signal Co., is receiving bids for the construction of a 5 story office building. Estimated cost $500,000. Janssen & Cocken, Century Bldg., Pittsburgh, Pa., are architects.

Tenn., Nashville—Bd. of Hospital Comrs., Y. W. Haley, Chn., will soon award contract for the construction of a boiler house at Nashville General Hospital.

Texas—Texas Electric Service Co., P. A. Rogers, V. Pres., Wichita Falls, plans the construction of a 100 mi. high voltage transmission line between Wichita Falls and Breckenridge, $275,000, also extensions and improvements to substations at Archer City and Holliday, $20,000, and erection of a substation at Graham, $75,000. Private plans. Machinery for substations will be required.

Tex., Brownsville—Sethman Corp., c/o R. C. Stehman, New York, N. Y., is having plans prepared for development of 400 acres of land for sub-division and citrus grove including pumping equipment, etc. Estimated cost $200,000. Private plans.

Wash., Bellingham—Leopold Hotel Co., will receive bids until May 15 for the construction of a 7 story hotel at Cornwell and Chestnut Sts. Estimated cost $500,000. H. I. Stevens Co., 30 North Michigan Ave., Chicago, Ill., is architect.

Wash., Seattle—Exter Co., Skinner Bldg., plans the construction of a 10 story apartment building at 8th and University Sts. Estimated cost $1,000,000. Stuart & Wheatley, Walker Bldg., are architects.

Ont., Niagara—Hydro Electric Power Commission of Ontario, 190 University Ave., Toronto, plans extensions and improvements to hydro-electric power plant here. Estimated cost $250,000. F. A. Gaby, is chief engineer. Transformers, switches, insulators, etc. will be required.

Ont., Toronto — Commercial Lands & Buildings Ltd, c/o Campbell & Shepperd, Northern Ontario Bldg., awarded contract for the construction of a 12 story office building at Bay and Albert Sts. to John V. Gray Construction Co. Ltd, 541 Queen St. E. Estimated cost $500,000. Steam heating system, electric elevators, etc. will be installed.

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Equipment Wanted

Boiler—Joint Bridge Committee of Essex and Hudson Counties, F. E. Ward, Clk, Newark, N. J., will receive bids until Apr. 7 for the installation of a vertical boiler on Jackson St. bridge over the Passaic River.

Engine Generator Sets and Generator—Electrical Engineers Ltd., Calgary, Alta., plans to purchase 100, 150 and 200 kw. engine generator sets, 3 ph., 60 cycle, 2,300 v. and 127 kw. generator, 2 ph., 60 cycle, 2,200 v., 257 r.p.m.

Engines and Generators—City of Crete, Neb., will receive bids until Apr. 2 for one 400 hp. and one 300 hp. oil engine direct connected to 375 kva. and 312 kva. generators for proposed power plant. Estimated cost $76,000.

Gas Engines—E. L. Vegeley, Clk., Santa Ana, Calif., plans to purchase one 120 and 160 hp. gas engines.

Ice Making Equipment—P. Bernhardt, Preston, Ont., plans the installation of ice making equipment, etc. in brewery. Estimated cost $45,000.

Power Unit—City, B. F. DeLanty Mgr., Pasadena, Calif., plans the installation of a 15,000 kw. additional power unit.

Pump—City of Oakland, Calif., is receiving bids for one 600 to 800 g.p.m. deep well turbine pump against a 100 to 150 ft. head for waterworks.

Pump—DeW. H. Donaldson, Mayor and City Council of Laurel, Md., will receive bids until Mar. 30 for furnishing and installing a 500 g.p.m. centrifugal pump with Diesel engine.

Pump and Motor—City of Amarillo, Tex., will soon receive bids for a centrifugal pump and motor for proposed sewage pumping station, etc. Estimated cost $26,000.

Pump and Motor—La Mesa, Lemon Grove and Spring Valley Irrigation Dist., La Mesa, Calif., will receive bids until Apr. 5 for a centrifugal booster pump and motor, etc.

Pump and Motor—E. F. Lennon, Clk, Red Bluff, Calif., will receive bids until Apr. 4 for a 1,200 g.p.m. single stage high speed horizontal centrifugal pump direct connected to motor.

Pump and Motor—E. L. Vegely, Clk, Santa Ana, Calif., plans to purchase one deep well turbine pump and 100 hp. vertical motor.

Pumps—Bd. of Water Comrs., Racine, Wis., will receive bids until Apr. 4 for one 10,000,000 g.p.m. turbo centrifugal pump and generator unit and one 10,000,000 g.p.m. motor driven centrifugal pump for proposed waterworks improvements.

Pumps and Motors, Etc. — T. Foster, Mayor, City Hall, Toronto, Ont., will receive bids until Apr. 5 for one duplex outside center packed boiler feed pump, one vertical centrifugal pump, electric motor, etc. Estimated cost $10,000.

Refrigeration Plant — Bd. of County Comrs., H. E. Thornburgh, Auditor, Richmond, Ind., will receive bids until Apr. 9 for a 25 cycle electric refrigeration plant for County Infirmary.

Switch Gear and Metering Equipment—Dept. of Public Works, Wellington, N. Z., will receive bids until June 2 for three sets of 11,000 v. iron clad switch gear and metering equipment for Arspuni electric power scheme.

Transformers—Toronto Electric Comrs., 12 Adelaide St. E., Toronto, Ont., will receive bids until Mar. 30 for eight 1,000 kva. single ph. transformers, oil switches, circuit breakers, switchboards, etc., for proposed electric sub-station. Estimated cost $150,000.